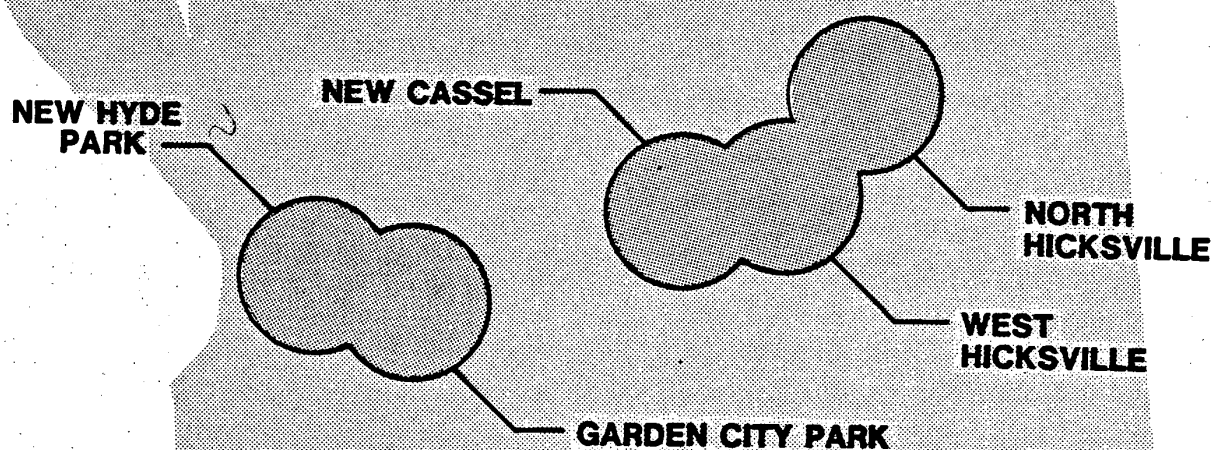


182594



INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS NASSAU COUNTY, NY



**NASSAU COUNTY DEPARTMENT OF HEALTH
AND**



**DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS
SYOSSET, NEW YORK**

June 1986

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS

NASSAU COUNTY, NEW YORK

JUNE 1986

NASSAU COUNTY DEPARTMENT OF HEALTH

AND

DVIRKA AND BARTILUCCI, CONSULTING ENGINEERS
SYOSSET, NEW YORK

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS
NASSAU COUNTY, NEW YORK

TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| Summary | S-1 |
| 1.0 Introduction | 1-1 |
| 1.1 Project Background | 1-1 |
| 1.2 Purpose and Scope | 1-3 |
| 1.3 Study Approach | 1-5 |
| 1.4 Regional Hydrogeologic Setting | 1-8 |
| 1.5 Regional Groundwater Quality | 1-12 |
| 2.0 Description of Monitoring Program | 2-1 |
| 2.1 Design and Installation of Monitoring Wells | 2-1 |
| 2.1.1 Drilling Methods | 2-2 |
| 2.1.2 Well Construction | 2-2 |
| 2.1.3 Well Development | 2-4 |
| 2.2 Sampling Procedures | 2-5 |
| 2.2.1 Water Level Measurements | 2-5 |
| 2.2.2 Water and Soil Sampling | 2-6 |
| 2.3 Analytical Procedures | 2-7 |
| 3.0 Monitoring Program Results | 3-1 |
| 3.1 Methodology for Site-Specific Assessment | 3-1 |
| 3.2 New Cassel | 3-3 |
| 3.2.1 Site Description | 3-3 |
| 3.2.2 Geology | 3-6 |
| 3.2.3 Hydrology | 3-7 |
| 3.2.4 Analytical Results and Findings | 3-8 |
| 3.3 Garden City Park | 3-15 |
| 3.3.1 Site Description | 3-15 |
| 3.3.2 Geology | 3-17 |
| 3.3.3 Hydrology | 3-18 |
| 3.3.4 Analytical Results & Findings | 3-19 |

TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| 3.4 New Hyde Park (Garden City Park West) | 3-20 |
| 3.4.1 Site Description | 3-20 |
| 3.4.2 Geology | 3-23 |
| 3.4.3 Hydrology | 3-24 |
| 3.4.4 Analytical Results and Findings | 3-25 |
| 3.5 West Hicksville | 3-27 |
| 3.5.1 Site Description | 3-27 |
| 3.5.2 Geology | 3-31 |
| 3.5.3 Hydrology | 3-32 |
| 3.5.4 Analytical Results and Findings | 3-32 |
| 3.6 North Hicksville | 3-36 |
| 3.6.1 Site Description | 3-36 |
| 3.6.2 Geology | 3-37 |
| 3.6.3 Hydrology | 3-38 |
| 3.6.4 Analytical Results and Findings | 3-39 |
| 4.0 Contaminated Aquifer Management and Remedial Alternatives | 4-1 |
| 5.0 Recommendations | 5-1 |

Appendices

- A Lithologic Unit Descriptions
- B Well Construction Diagrams
- C Well Survey Diagrams
- D Nassau County Water Quality Maps

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS
NASSAU COUNTY, NEW YORK

LIST OF TABLES

| Table No. | Title | Follows Page |
|--------------|--|-----------------|
| 1-1 | Volatile Organic Levels in Wells by Aquifer (October 1983- September 1984) | 1-15 |
| 1-2 | Volatile Organic Levels in Wells by Aquifer (July 1976 - September 1984) | 1-15 |
| 2-1 | Wells Installed During Each Phase of Drilling | 2-1 |
| 2-2 | Water Level Measurements for New Cassel Monitoring Wells | 2-6 |
| 2-3 | Water Level Measurements for Garden City Monitoring Wells | 2-6 |
| 2-4 | Water Level Measurements for New Hyde Park Monitoring Wells | 2-6 |
| 2-5 | Water Level Measurements for North Hicksville Monitoring Wells | 2-6 |
| 2-6 | Water Level Measurements for West Hicksville Monitoring Wells | 2-6 |
| 3-1 | Industrial Profile of New Cassel | 3-5 |
| 3-2 | Analytical Results - New Cassel Groundwater Quality | 3-9 |
| 3-3 | New Cassel - Total Organic Compounds Data Summary | 3-9 |
| 3-4 | Industrial Profile of Garden City Park | 3-17 |
| 3-5 | Analytical Results - Garden City Park Groundwater Quality | 3-19 |

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS
NASSAU COUNTY, NEW YORK

LIST OF TABLES

| Table No. | Title | Follows Page |
|--------------|--|-----------------|
| 3-6 | Garden City Park - Total Organic Compounds Data Summary | 3-19 |
| 3-7 | Industrial Profile of New Hyde Park | 3-22 |
| 3-8 | Analytical Results - New Hyde Park Groundwater Quality | 3-25 |
| 3-9 | New Hyde Park - Total Organic Compounds Data Summary | 3-25 |
| 3-10 | Industrial Profile of West Hicksville | 3-28 |
| 3-11 | Analytical Results - West Hicksville Groundwater Quality | 3-33 |
| 3-12 | West Hicksville Total Organic Compounds Data Summary | 3-33 |
| 3-13 | Industrial Profile of North Hicksville | 3-37 |
| 3-14 | Analytical Results - North Hicksville Groundwater Quality | 3-39 |
| 3-15 | North Hicksville - Total Organic Compounds Data Summary | 3-39 |
| 4-1 | General Response Actions and Associated Remedial Technologies | 4-1 |
| 4-2 | Alternative Remedial Technologies to Address Identified Site Problems | 4-1 |
| 4-3 | Site Characteristics that May Affect Remedial Technology Selection | 4-3 |
| 4-4 | Waste Characteristics That May Affect Remedial Technology Selection | 4-3 |

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS
NASSAU COUNTY, NEW YORK

LIST OF FIGURES

| Figure No. | Title | Follows Page |
|---------------|---|-----------------|
| 1-1 | Location of Sites Overlying Contaminated Aquifer Segments in Nassau County | 1-6 |
| 1-2 | Nassau County Hydrogeologic Cross-Section | 1-8 |
| 1-3 | Nassau County Water Table Elevations in Nassau County | 1-11 |
| 1-4 | Potentiometric Surface of the Magothy Aquifer in Nassau County | 1-11 |
| 1-5 | Potentiometric Surface of the Lloyd Aquifer in Nassau County | 1-11 |
| 2-1 | Typical 2 Inch Diameter Monitoring Well Design and Installation | 2-4 |
| 2-2 | Typical 4 Inch Diameter Monitoring Well Design and Installation | 2-4 |
| 3-1 | Location Map of New Cassel, West Hicksville and North Hicksville | 3-3 |
| 3-2 | New Cassel - Well Location and Identification | 3-3 |
| 3-3 | New Cassel - Hydrogeologic Cross-Section | 3-6 |
| 3-4 | New Cassel - Water Level Contours | 3-7 |
| 3-5 | New Cassel - Water Quality-Total Volatile Organics | 3-9 |
| 3-6 | Location Map of Garden City Park and New Hyde Park | 3-15 |
| 3-7 | Garden City Park - Well Location and Identification | 3-15 |
| 3-8 | Garden City Park - Hydrogeologic Cross-Section | 3-17 |

INVESTIGATION OF CONTAMINATED AQUIFER SEGMENTS
NASSAU COUNTY, NEW YORK

LIST OF FIGURES

| Figure No. | Title | Follows Page |
|---------------|--|-----------------|
| 3-9 | Garden City Park - Water Level Contours | 3-18 |
| 3-10 | Garden City Park - Water Quality- Total Volatile Organics | 3-19 |
| 3-11 | New Hyde Park - Well Location and Identification | 3-21 |
| 3-12 | New Hyde Park - Hydrogeologic Cross-Section | 3-23 |
| 3-13 | New Hyde Park - Water Quality- Total Volatile Organics | 3-25 |
| 3-14 | West Hicksville - Well Location and Identification | 3-27 |
| 3-15 | West Hicksville - Hydrogeologic Cross-Section | 3-31 |
| 3-16 | West Hicksville - Water Level Contours | 3-32 |
| 3-17 | West Hicksville - Water Quality- Total Volatile Organics | 3-33 |
| 3-18 | North Hicksville - Well Location and Identification | 3-36 |
| 3-19 | North Hicksville - Hydrogeologic Cross-Section | 3-38 |
| 3-20 | North Hicksville - Water Quality- Total Volatile Organics | 3-39 |

ACKNOWLEDGEMENTS

This investigation and report is the result of a joint effort between Nassau County Department of Health and Dvirka and Bartilucci, Consulting Engineers.

We appreciate the cooperation and assistance of the Nassau County Department of Health, Division of Environmental Health, and the Division of Laboratories and Research; particularly Mr. Francis V. Padar, Deputy Commissioner and Dr. Richard Altieri, Director. We also wish to thank Mr. Sheldon Smith, Deputy Director, Division of Environmental Health; Mr. Michael Alarcon, Director, Bureau of Public Water Supply; Mr. Donald Myott, Chief, Office of Groundwater Management; Mr. Marvin Fleisher, Deputy Director, Bureau of Land Resources Management; and Mr. James Adamski, Director of Environmental Health Laboratory.

Special recognition goes to Mr. Ricky Chenenko, Department of Health and Mr. Rick Liebe, Department of Public Works for their assistance and cooperation in performance of this project and preparation of this report.

SUMMARY

As part of an overall effort to identify and mitigate groundwater contamination by synthetic organic chemicals, the New York State Legislature, through the New York State Health Department (NYSHD) appropriated special funding to conduct groundwater investigation programs on Long Island. Under contract with NYSHD, the Nassau County Department of Health (NCDH) has undertaken six special groundwater projects. The sixth of these projects, which is the investigation of sites of groundwater contamination by synthetic organic chemicals in Nassau County is the subject of this report.

To assist NCDH in the performance of this investigation, the County retained Dvirka and Bartilucci, Consulting Engineers, Syosset, New York, to provide environmental engineering and geohydrological services.

The purpose of this Investigation of Contaminated Aquifer Segments in Nassau County is to identify the most significant sites of groundwater contaminated by organic chemicals in the County, and to determine the extent, source and alternative methods for management of the contamination.

Based on a comprehensive assessment of organic chemical contamination of groundwater and water supply conducted under this investigation, and consideration of other current or planned

investigations, five sites were selected for this project. These sites center about industrial areas located in New Cassel; North Hicksville; West Hicksville; Garden City Park; and New Hyde Park.

As part of this study, 59 monitoring wells were installed. The locations of the wells drilled during Phase I of the project (29) were selected based upon a survey of industries in each of the areas, that according to NCDH records, handled synthetic organic chemicals. The locations of the Phase II wells (30) were selected to establish groundwater quality upgradient of the sites and to better define the extent of contamination, as well as to begin to identify possible contaminant sources.

In addition to the new wells installed as part of this project, data from 19 existing Nassau County monitoring wells and 18 public water supply wells were used in the investigation.

Based upon the results of data obtained from these wells, evaluation of site specific and regional hydrogeology, and assessment of information concerning possible contaminant sources, the findings in each area are summarized below. The order in which the sites are discussed reflects the severity of groundwater contamination and threat to water supply.

o New Cassel - Extensive and substantial contamination of groundwater is found in this area. Six wells have levels of

total volatile organic chemicals above 1000 ug/l, with a maximum concentration of nearly 10,000 ug/l. Results of upgradient monitoring wells appear to isolate the industrial area south of the Long Island Railroad and north of Old Country Road as the source.

Downgradient wells indicate that contamination in concentration of a maximum of 1,000 ug/l total organics has migrated at least 1,600 feet from the industrial area. Other further downgradient wells show that contamination has migrated at least 3,000 feet in concentrations of about 100 ug/l. Deeper wells in and downgradient of the industrial area also indicate that contamination has migrated into the Magothy aquifer to at least 260 feet below the ground surface and in significant concentrations (2,700 ug/l) at about 100 feet.

Although at the present time this contamination does not impact public water supply wells in the area, there is a potential threat to water supply, particularly to the Bowling Green Water District, because of the high levels of organic chemicals found and the apparent absence of an aquaclude below and downgradient of the industrial site.

- o Garden City Park - Substantial contamination of groundwater (concentrations of 51,000 ug/l were detected in one well and 2,600 ug/l in a second well) is found in this area. Based on existing information, however, the contamination is not as widespread as in New Cassel comparing suites of compounds detected as well as areal extent.

It is probable that the majority of groundwater contamination in Garden City Park originates from an industrial area along and west of Herricks Road and north of the Long Island Railroad. Although upgradient wells do not isolate the area source of contamination, downgradient wells essentially all exhibit contamination (greater than 100 ug/l total volatile organics). Other sources located in industrial areas along the railroad, however, may also be contributing factors.

The one existing water supply well in the immediate vicinity of the study area is slightly contaminated with organic compounds (10 ug/l). Although data is limited with regard to deep monitoring wells in this area, one monitoring well 100 feet below the surface indicates that the upper Magothy shows significant contamination (up to nearly 200 ug/l total organic compounds). Since Garden City Park is part of the Magothy recharge area, there is the potential for further contamination of water supply in the future.

- o West Hicksville - Some significant (maximum of 6,800 ug/l) and extensive contamination of groundwater was found in the area of West Hicksville. Although there are no upgradient monitoring wells, it appears based on land use that contamination is originating from the industrial area along West John Street and Duffy Avenue parallel to the Long Island Railroad. A number of

waste disposal violations and spills have been reported in this area. Based on data obtained from deep monitoring wells in the area, contamination (approximately 2,700 ug/l total volatile organics) has migrated into the Magothy aquifer up to 265 feet below the surface. Although no water supply wells within and downgradient of the study area are presently contaminated with organic chemicals, there is a potential threat to water supply wells in the Bowling Green Water District. Clay layers that would impede contaminant migration are identified in deeper wells in West Hicksville, however, the stratigraphic continuity is unknown.

- o New Hyde Park - Significant, but limited contamination of groundwater has been reported for existing wells in this area (maximum of 3,600 ug/l). Wells installed as part of this project detected little or no contamination. There is substantial industrial land use in New Hyde Park that could be contributing to groundwater contamination. Additional information is needed at this site to determine sources and extent of the contamination.

There were no deep monitoring wells installed as part of this investigation in the New Hyde Park area; therefore, there is limited data with regard to vertical contaminant migration and contamination of the upper Magothy aquifer. However,

because New Hyde Park is part of the regional Magothy recharge area flow regime, and continuous confining clays in the Magothy are not known to exist in this area, there is the potential for deep contamination of groundwater. Two public water supply wells located about 2,000 feet downgradient of the most significant contamination in the Jamaica Water Supply District are contaminated with total volatile organics up to about 70 ug/l. These wells are treated before distribution of water supply.

- o North Hicksville - Limited degree of groundwater contamination (maximum of about 1,000 ug/l) has been detected in North Hicksville. Upgradient wells indicate that the probable sources of contamination are within the industrial areas located along the Long Island Railroad. However, since North Hicksville was sewered only recently, contamination may also be the result of household chemical waste disposal. The extent of downgradient contamination is unknown.

Based on the results of deep monitoring and water supply wells, there is evidence of contamination in the Magothy aquifer up to 575 feet below the surface. Two Hicksville Water District wells in the study area are being treated for the removal of volatile organic chemicals. Although the data is limited, and there is impairment of the two water supply wells, it does not appear that groundwater contamination is gross or widespread.

There was only preliminary study in each of these five areas, and therefore additional monitoring wells (shallow and deep) need to be installed to define the extent and sources of contamination, as well as detailed facility surveys in the site specific industrial areas to verify the sources and to develop appropriate remedial measures.

In order to accomplish this objective, the Nassau County Department of Health should either undertake further investigation as part of a County remedial program, or seek to have these sites placed on the Federal and/or New York State Superfund List for additional preliminary study or Remedial Investigation and Feasibility Study.

Detailed locations for additional wells cannot be provided at this time based on limitations of existing information. Well locations should be defined only after additional, more detailed facility surveys and inspections have been conducted to determine possible sources of contamination. Wells should be placed both upgradient and downgradient of suspected facilities to isolate contamination sources. Additional wells should also be installed downgradient of the study areas to define the horizontal and vertical extent of groundwater contamination and threat to sources of water supply.

For each of the study sites, recommendations for specific remedial action cannot be provided based on the limited data gathered in this study. Site specific mitigation measures can only be developed after the extent and source of contamination has been defined. The most applicable mitigation measures in these study areas, based on a preliminary screening of technological alternatives, are the following:

- o Excavation and off-site removal of contaminated water, sludges and soils
- o Impermeable surface seals (capping) to minimize contaminant leaching
- o Subsurface contaminant barriers (such as slurry walls, grout curtains and vibrating beams), with pumping wells to control and recover contaminated groundwater
- o Soil flushing systems with subsurface barriers and recovery systems to clean contaminated soils
- o Onsite Treatment (air or steam stripping and carbon adsorption), with groundwater discharge, or pretreatment with discharge to a municipal treatment facility.

In addition to continued investigation in the five sites selected as part of this study, similar investigation should be undertaken in other areas of Nassau County identified as overlying contaminated aquifer segments. These areas include Lake

Success and Glen Cove. (Other areas of groundwater contamination in the Roosevelt Field and Bethpage-Hicksville areas are being studied.) Monitoring wells should also be installed in industrial areas of the County which are presently not monitored for groundwater contamination. This is particularly important in the unsewered areas which are in the deep water supply recharge zone.

1.0 INTRODUCTION

1.1 Project Background

Since 1975, when significant concentrations of vinyl chloride, tetrachloroethylene and trichloroethylene were discovered in water supply wells within an industrial complex in the southeastern part of the County, the Nassau County Department of Health (NCDH) has undertaken an extensive program to determine the extent and sources of organic chemical contamination in the aquifer system underlying Nassau County. Initially, the management approaches employed by the Health Department involved sampling and restricting the use of public water supply wells to protect public health, and surveying industrial and commercial establishments to identify and abate sources of organic chemicals.

As a result of these surveillance programs, 420 public water supply wells are sampled routinely at least once each year for synthetic organic chemicals, and over 4,000 industrial/-commercial establishments have been surveyed since 1976. Based on these programs, 15 public water supply wells are currently restricted because levels of organic contaminants exceed New York State Guidelines for drinking water, and wastewater discharges from 40 establishments are controlled by permits issued as part of the New York State Pollutant Discharge Elimination System (SPDES). In addition, 200 facilities which store and dispose of

organic chemical products and wastes (including fuel oil and gasoline storage tanks) are regulated under Article Eleven of the Nassau County Sanitary Code, and 35 petroleum discharge permits have been issued in the county.

In addition to industrial and commercial waste disposal, an extensive investigation into the uses of toxic household products determined that unsewered residential areas may also be a significant source of organic chemical contamination of groundwater. As a result of this determination, sales of organic chemical cesspool and drain cleaners were banned on Long Island in 1980 by State law.

With the successful implementation of organic chemical monitoring in groundwater and source control programs, Nassau County has initiated a third management approach which entails the mitigation of existing groundwater contamination. This approach involves defining the extent of contamination, determining sources (if possible), and identifying the need for remedial programs. Remedial actions that have been undertaken by either County, State or Federal agencies at selected sites to date include: excavation and removal of contaminated soils and sludges; containment of contaminated groundwater and soil with subsurface barriers and surface seals; aquifer restoration by pumping and treatment; installation of water supply monitoring systems; and provision of contingencies for water supply treatment or alternate supplies.

As part of this overall effort to identify and mitigate groundwater contamination by organic chemicals, the New York State Legislature, through the New York State Health Department (NYSHD) appropriated special funding to conduct Groundwater Investigation Programs on Long Island. Under contract with NYSHD, the Nassau County Department of Health (NCDH) has undertaken six special groundwater projects. These projects comprise:

1. Broad Spectrum Organic Chemical Testing
2. Comprehensive Glacial Aquifer Monitoring
3. Automated Data Processing
4. Investigation of a Contaminated Aquifer Segment (Roosevelt Field)
5. Investigation of Landfill Impact on Groundwater Quality (Syosset and Denton Avenue Landfills)

The sixth of these special projects, which is the subject of this report, is the investigation of sites of groundwater contaminated by synthetic organic chemicals. To assist in the performance of this investigation, NCDH retained Dvirka and Bartilucci, Consulting Engineers of Syosset, New York, to provide environmental engineering and geohydrological technical services.

1.2 Purpose and Scope

The purpose of this study is to identify the most significant sites of groundwater contaminated by organic chemicals in

Nassau County which have not already been investigated. Primary emphasis is given to those sites which pose the greatest threat to public water supply sources.

The scope of this investigation consists of the following tasks:

1. Review data available from NCDH's groundwater quality monitoring network and hydrogeologic information at the site of significant areas of contamination, as well as available records and data concerning past and present potential sources of contamination including industrial, commercial, residential and municipal facility discharges.
2. Rank and select areas for subsurface investigation on the basis of potential threat to sources of public water supply within the budget constraints of this project.
3. Design and implement procedures and specifications for subsurface investigation.
4. Evaluate the results of soil and water quality testing to determine the extent and source of groundwater contamination at each of the sites studied, and prepare a report on the methodology followed and findings of the study, including recommendations for legal, administrative and technical procedures for management of the contaminated aquifer and soil segments.

Tasks 1 and 2 were conducted jointly by NCDH and Dvirka and Bartilucci, Consulting Engineers. Task 3 was performed by NCDH, and Task 4 was performed by Dvirka and Bartilucci, with substantial assistance from NCDH.

1.3 Study Approach

Prior to this study, the most recent comprehensive assessment of organic chemical groundwater contamination in Nassau County was undertaken in 1978. In order to provide an updated assessment of groundwater quality in the County to determine the most critical areas of groundwater contamination and to select specific sites for subsurface investigation, maps of Nassau County were prepared showing the locations and depths of all water supply and monitoring wells. Superimposed on these maps was the most recent data for organic chemicals. Except for public water supply wells, analytical data for organic compounds were compared to New York State Drinking Water Guidelines for total volatile organic chemicals. For water supply wells, the chemicals were also compared to New York State Drinking Water Guidelines for individual chemicals. Based on this method of assessment, wells were classified into four contamination categories for total volatile organics and individual chemicals as tabulated below. The maps illustrating this information are provided in Appendix D of this report.

CONTAMINATION CATEGORIES FOR ORGANIC CHEMICALS

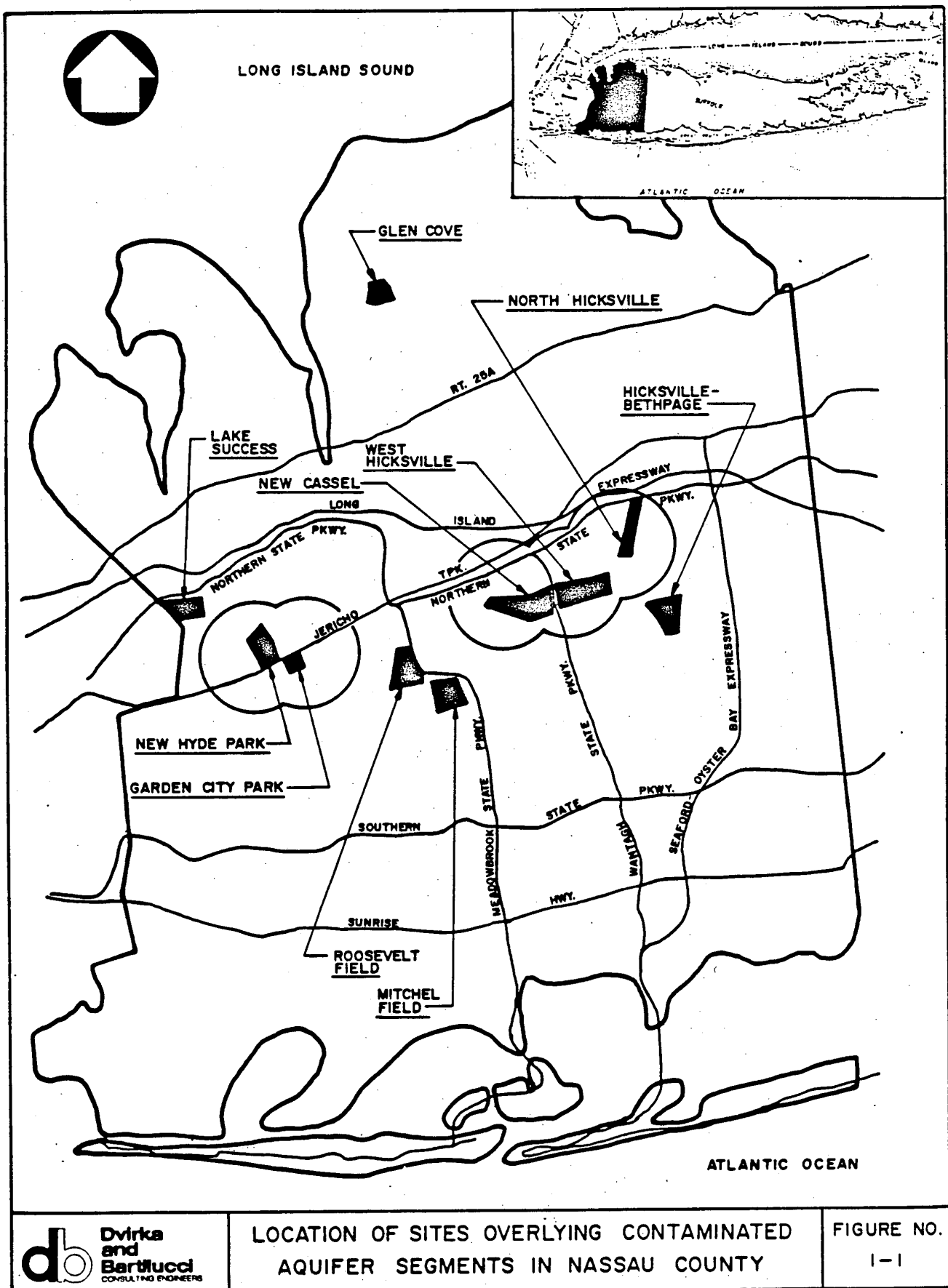
| <u>Category</u> | <u>Total Volatile Organics* (ug/l)</u> | <u>Individual Chemicals* (ug/l)</u> |
|---------------------------|--|---|
| Ambient/Near Ambient | ND-10 | ND-5 |
| Contaminated | 10-100 | 5-50 |
| Significant Contamination | 100-1000 | 50-500 |
| Gross Contamination | >1000 | >500 |

*Drinking Water Guideline (100 ug/l for total volatile organics and 50 ug/l for an individual compound except for benzene and vinyl chloride for which the guideline is 5 ug/l)

As a result of this evaluation and chemical inventory information obtained from industrial surveys conducted by NCDH, ten areas of significant groundwater contamination by organic chemicals were identified in Nassau County. These areas are:

1. Mitchel Field
2. Roosevelt Field
3. Glen Cove
4. Hicksville-Bethpage
5. Lake Success
6. North Hicksville
7. West Hicksville
8. New Cassel
9. New Hyde Park
10. Garden City Park

Locations of these areas are shown in Figure 1-1.



The areas of Mitchel Field, Roosevelt Field and Hicksville-Bethpage were excluded from investigation in this project because other studies were ongoing or planned for these sites. Glen Cove and Lake Success were excluded primarily because the depth to groundwater was too great (over 100 feet) and subsurface investigation of these areas would have been too costly given the limited funds for this project. Glen Cove was also excluded since it is not located in the Magothy recharge area. As a result of these determinations the sites selected for groundwater investigation as part of this project were: North Hicksville; West Hicksville; New Cassel; New Hyde Park; and Garden City Park.

A two phase approach was then taken in the design of the monitoring network in the five study areas. Initially, a survey of each of the sites to identify users of synthetic organic chemicals was performed in conjunction with the Department of Health. In Phase I, wells were installed within and downgradient of the industrial areas with special attention given to the facilities identified which handled substantial amounts of these chemicals. The data obtained from these wells was used to determine which monitoring networks would be expanded during Phase II.

Based on the degree of contamination found in Phase I, only well networks in New Cassel and Garden City Park were

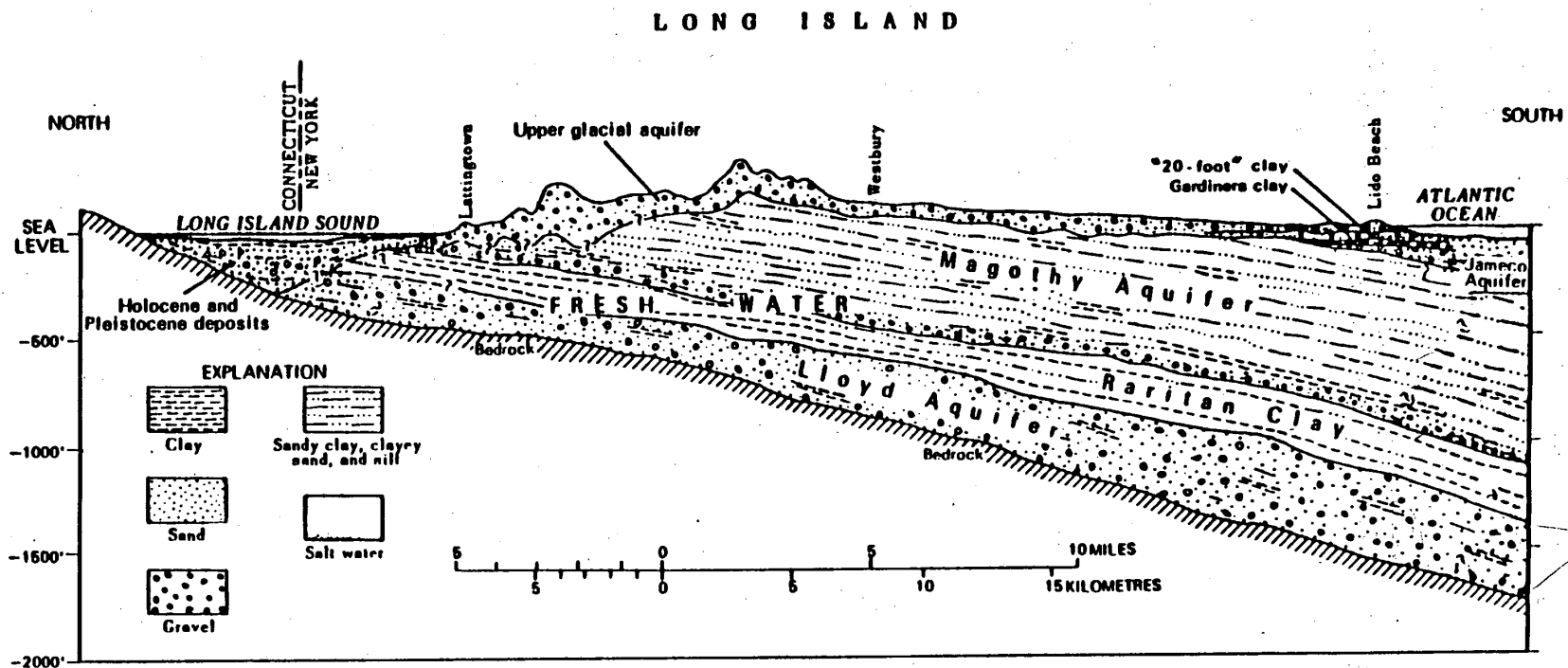
expanded during Phase II. New Hyde Park well NHP-3, however, was raised 12 feet in order to sample a higher portion of the aquifer immediately below the water table. It was felt that this well, which was contiguous and downstream of an auto wrecking yard, may have been screened too deep and missed picking up contamination.

Phase II well locations were chosen within the industrial areas where more information was needed in view of the Phase I results and potential sources. In addition, wells were placed further downgradient in an attempt to define the extent of contamination, as well as upgradient of the areas under study to obtain background information.

All wells were located on public land or municipal water supply property because of the potential legal and time constraints inherent in attempting to gain access to private property.

1.4 Regional Hydrogeologic Setting

The aquifer system underlying Nassau County (Figure 1-2) is composed of three main water bearing units: the glacial, Magothy and Lloyd formations. These aquifers are hydraulically connected throughout, and the glacial and Magothy aquifers act as recharge for underlying units. The upper glacial aquifer, although not generally used for drinking water due to widespread contamination, is important because it serves as recharge for all underlying aquifers in the central portion of the County.



Generalized section in central Nassau County showing principal aquifers and confining units (after Perlmutter and Geraghty, 1963, fig. 3).

The oldest rocks in the area are weathered and crystalline bedrock of Lower Paleozoic and (or) Precambrian age that form a virtually impermeable base for the groundwater reservoir.

Upper Cretaceous coastal plain deposits of continental and marine origin overlay the bedrock. These deposits have been subdivided into three hydrogeologic units which are, from oldest to youngest, the Lloyd aquifer, the Raritan clay and the Magothy aquifer. These units are present throughout most of the County and are recognized as distinct hydrogeologic units. The deposits dip and thicken to the southeast with the maximum thickness being about 1,500 feet.

The Lloyd aquifer is the oldest and deepest water bearing unit. It rests upon bedrock and consists of lenticular deposits of clay, silt, sandy clay, sand and gravel. The top of the aquifer dips southeast from about 500 feet below sea level in the northern part of the study area to more than 1,400 feet below sea level at the southern tip of Nassau County. The Lloyd aquifer is about 200-300 feet in thickness in the study area. Although there are a few Lloyd wells in central Nassau County, this aquifer is used as a primary source of water supply only along the north shore of the County where the Magothy aquifer does not exist and in the Long Beach-Lido Beach area (extreme southern portion of Nassau County) when the Magothy is salted. Water in

the Lloyd aquifer is confined beneath the Raritan clay. The aquifer is believed to be hydraulically continuous with the Magothy in Nassau County.

The Raritan clay, which overlies the Lloyd formation, is a significant confining unit that consists mainly of clay and silty clay, and some sandy clay and sand in the upper portion. The clay has a very low hydraulic conductivity but does not totally prevent movement of water between the Magothy and the underlying Lloyd aquifer. The clay ranges from 0 to about 200 feet in thickness.

The Magothy aquifer is the principal source of water supply underlying Nassau County. It consists mainly of lenticular beds of very fine to medium sand that are interbedded with clay and sandy clay, silt, and some sand and gravel. Most of the clay is in the upper half of the unit. Beds of coarse sand with gravel are found in most, but not all, locations in the lower 100 to 150 feet of the unit. The aquifer is non-existent in many areas along the north shore and reaches maximum thickness in the southern part of Nassau County where its extent is about 1,000 feet.

The upper glacial aquifer consists of deposits of late Pleistocene and recent (Holocene) age that overlie the Magothy aquifer. The top of the upper Pleistocene deposits is the

present land surface, except where they are locally overlain by thin deposits of Holocene age. The deposits in Nassau County are generally highly permeable glacial outwash consisting of stratified sand and gravel and occasional thin clay beds. The saturated upper glacial aquifer is about 100 feet thick in the study area. Depth of the vadose or unsaturated zone in the County ranges from about 125 feet in the northern portion to about 20 feet along the south shore.

Water table contours and shallow groundwater flow in the study area are shown in Figure 1-3. The flow direction in the eastern Nassau County is northeast in the area north of the groundwater divide and almost due south, south of the divide. Towards the western part of the County the groundwater follows a general northwest and southwest flow pattern north and south of the groundwater divide respectively.

Groundwater flow in the Magothy aquifer (Figure 1-4) is similar to the shallower flow regime.

Groundwater in the Lloyd aquifer in eastern Nassau County flows in a northern direction, north of the groundwater divide and south of the divide in a more westward direction with less southerly components than the shallower flow regimes (Figure 1-5). In the western portion of the County, groundwater flow is in a westerly direction, both north and south of the divide.

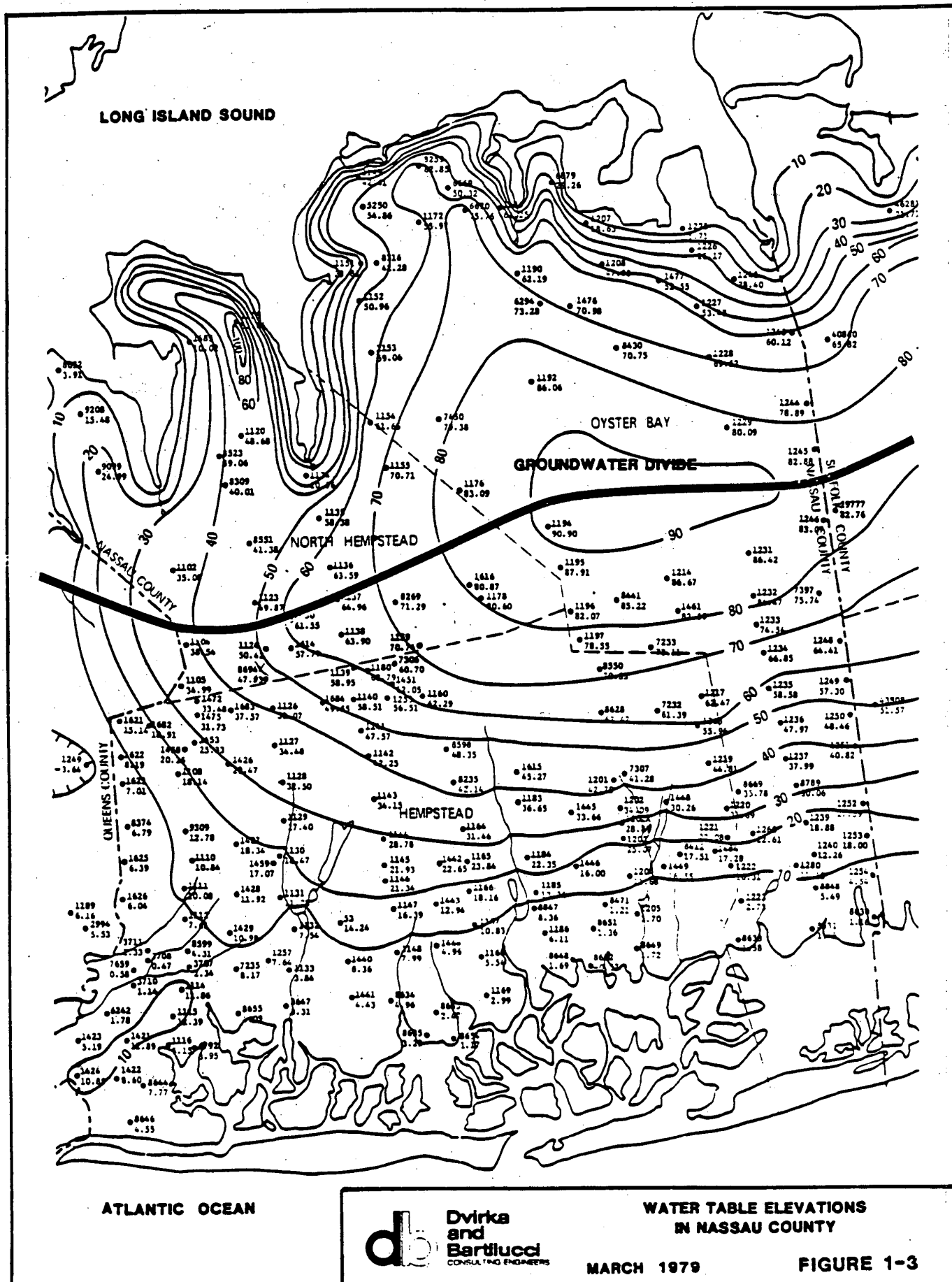
Because this groundwater system is the only source of drinking water for Nassau County (as well as Suffolk County), it has been designated a Sole Source Aquifer by the United States Environmental Protection Agency (USEPA).

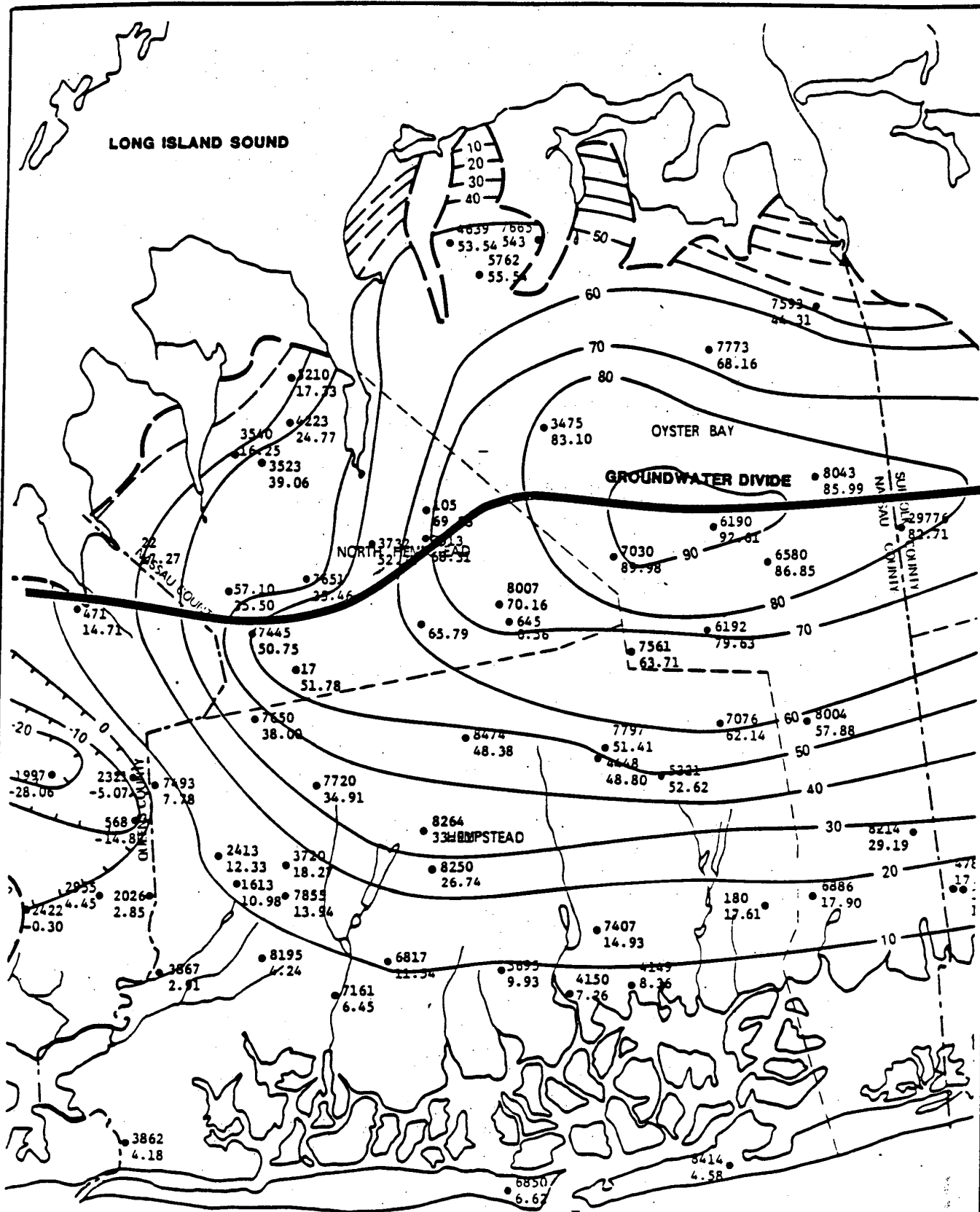
1.5 Regional Groundwater Quality

In Nassau County there are four groundwater contaminants of concern, these being nitrate, chloride, heavy metals and synthetic organic chemicals. (A fifth is iron; however, this is a naturally occurring contaminant and is not included in this discussion.)

Nitrate contamination of the glacial aquifer in Nassau County is widespread geographically and extends into the Magothy formation. Levels in many locations of the glacial aquifer, except for the extreme south shore and limited areas on the north shore, exceed the drinking water standard of 10 milligrams per liter (mg/l). Nitrate contamination of groundwater is caused primarily by onsite sewage disposal, lawn fertilizer application and past agricultural practices.

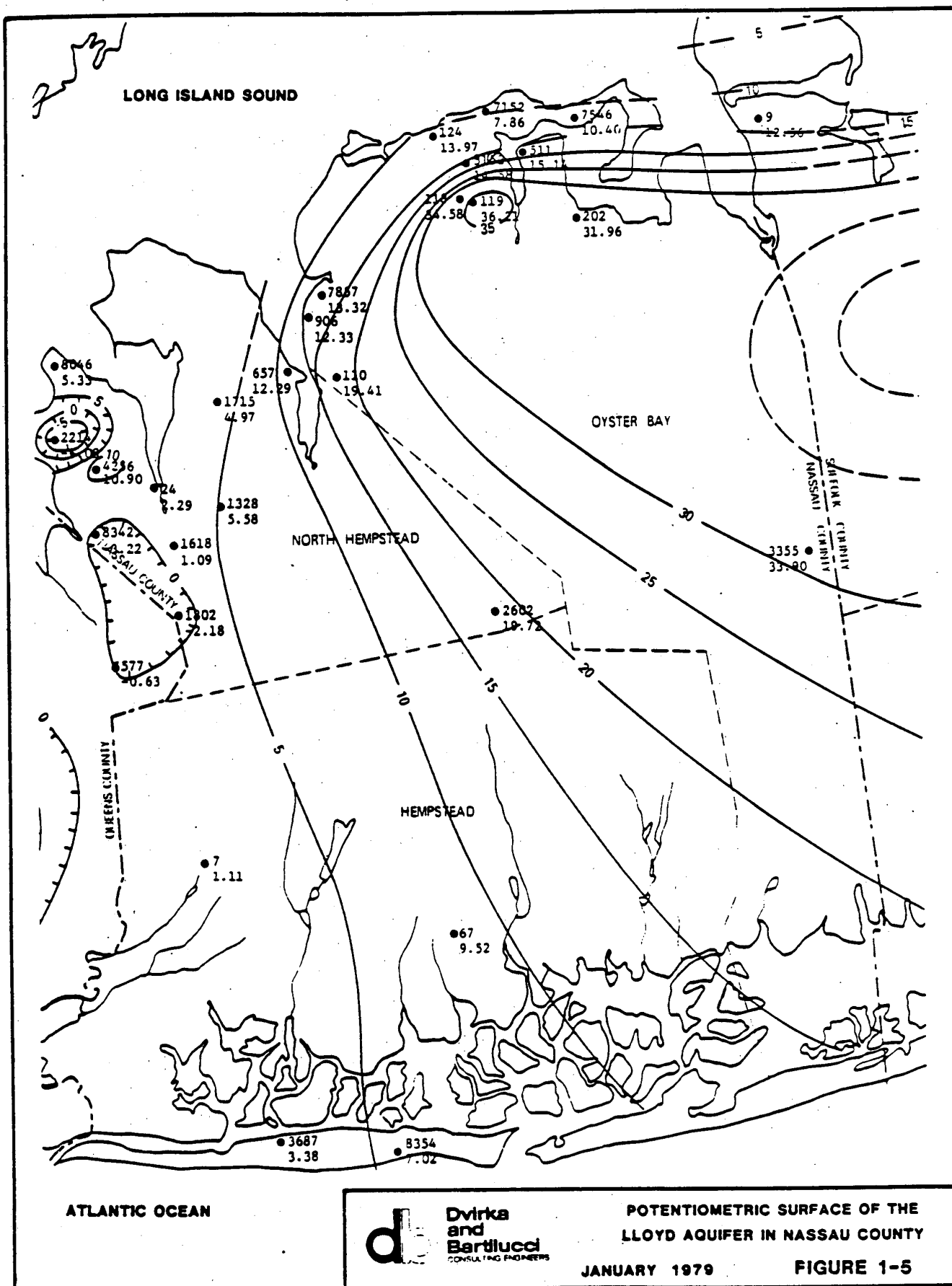
In the Magothy aquifer, elevated concentrations of nitrates are found in the central portion of the County where there is natural recharge of the Magothy from the overlying glacial aquifer, which is enhanced by heavy water supply pumpage by Magothy wells. Areas with elevated concentrations are in the





POTENTIOMETRIC SURFACE OF THE
MAGOTHY AQUIFER IN NASSAU COUNTY

R2-0000034



areas of Munsey Park, Garden City Park, East Meadow, Syosset, Bethpage and Levittown. Areas above 10 mg/l exist in both the northern and southern portions of Hicksville.

The Lloyd aquifer exhibits very little nitrate contamination.

Significant chloride contamination of groundwater in Nassau County is localized and confined to the areas of Kings Point and Long Beach-Lido Beach caused by saltwater intrusion, and in Port Washington due to sand mining (washing) operations. Levels above the drinking water standard of 250 mg/l are found in Mineola and Valley Stream which are attributable to leaching from road salt storage facilities.

Groundwater contamination caused by heavy metals is very limited in the County. Areas where concentrations of metals are elevated are in Syosset and North Hicksville. Two public water supply wells in North Hicksville have shown elevated levels of copper and heavy metals have been detected in monitoring wells at the Syosset Landfill. This contamination is most likely due to industrial waste disposal.

The fourth contaminant of significance in Nassau County is synthetic organic chemicals. Because these chemicals are fairly widespread and are considered public health significant in trace concentrations (many are known or suspected carcinogens), organic chemical contamination of groundwater is currently the major threat to water supply in the County.

The overall extent of contamination of drinking water sources by synthetic organic chemicals is demonstrated by the percentage of water supply wells at various ranges of concentration. Based on a comparison to current drinking water guidelines which are 50 ug/l for single compound (except for benzene and vinyl chloride which are 5 ug/l) data from 1976 to 1984 representing 434 public wells; 69% have non-detected (ND) levels; 21% are between ND and 10 ug/l; 8% are between 10 ug/l and 50 ug/l; and 3% exceed the guideline. In addition to the 14 public water supply wells which exceed the guideline because a single chemical is in excess of 50 ug/l, one well is currently restricted because the total of volatile organics is in excess of 100 ug/l, which is also the drinking water guideline. This contamination includes gasoline constituents (benzene, toluene and xylenes) and volatile halogenated organic chemicals. Illustrations of this contamination distribution is contained in Appendix D.

The most common organic compounds detected in water supply wells in Nassau County are trichloroethylene, tetrachloroethylene, and 1,1,1 trichloroethane detected in 24%, 22% and 17% of all wells tested respectively. Groundwater contamination caused by these compounds results primarily from the improper disposal of industrial wastes (solvents and degreasers); commercial wastes (e.g. dry cleaning fluids); use of cesspool and drain cleaners; and spills of chemicals, including gasoline.

Wells in the glacial aquifer exhibit a greater variety of synthetic organic chemicals detected in significantly higher concentrations compared to wells in the Magothy aquifer. This is because many of the glacial wells are in and immediately down-gradient of industrial areas, and are thus in closer proximity to contamination sources.

A comparison of organic chemical contamination in monitoring wells illustrates this widespread and often substantial contamination of the glacial aquifer in Nassau County by synthetic organic chemicals. Of the approximately 283 observation wells monitored in the County between 1976 and 1984, only 29% are non-detectable for any single organic chemical; 31% are between ND and 10 ug/l; 24% are between 10 and 50 ug/l; and 15% are above 50 ug/l. An overall summary of recent and historical organic chemical contamination in Nassau County by type of well and aquifer monitored is provided in Tables 1-1 and 1-2.

In some areas of the County such as Roosevelt Field and Garden City Park, levels ranging from 30,000 to 50,000 ug/l have been reported, and in Mitchel Field, concentrations of greater than 1,000,000 ug/l have been found near significant chemical spills.

Although there is widespread contamination of groundwater by organic chemicals in Nassau County, at the present time only

15 public water supply wells are restricted, and two of these are employing treatment. Based on this fact and current water quality guidelines, drinking water supply in general is of an acceptable quality in the County. Downward migration of contaminants from the glacial to the Magothy aquifer, however, may cause additional wells to be restricted in the future. In addition, promulgation of more stringent Federal standards for organic chemicals in groundwater (which is scheduled by USEPA for November 1986) may significantly exacerbate the problem and cause the restriction, or require treatment of an additional 55 water supply wells (17% of the total) in Nassau County.

For this reason it is important that sources of organic chemical contamination in the aquifer system be determined and abated, and contaminated soils and groundwater be mitigated to minimize any additional impairment of public water supply.

The investigation undertaken in this project is one of Nassau County's most significant initiatives in defining areas of major groundwater contamination and developing a basis for remedial action. Information from this study will aid in long term planning and management of the County's water supply sources.

TABLE 1-1

VOLATILE ORGANIC LEVELS IN WELLS BY AQUIFER

NASSAU COUNTY, NEW YORK

Data Between October 1, 1983 and September 30, 1984

| | <u>Wells Tested</u> | <u>None Detected</u> | <u><10 ug/l</u> | <u>>10 - <50 ug/l</u> | <u>>50 ug/l</u> |
|------------------|-------------------------|--------------------------|------------------------|---------------------------------|------------------------|
| A. Public Supply | | | | | |
| Glacial | 27 | 14 52% | 10 37% | 2 7% | 1 4% |
| Magothy | 274 | 194 71% | 52 19% | 25 9% | 3 1% |
| Lloyd | 33 | 25 76% | 7 21% | 1 3% | 0 0% |
| Subtotal | 334 | 233 70% | 69 21% | 28 8% | 4 1% |
| B. Monitoring | | | | | |
| Glacial | 88 | 23 26% | 31 35% | 23 26% | 11 13% |
| Magothy | 55 | 31 56% | 6 11% | 2 4% | 16 29% |
| Lloyd | 5 | 3 60% | 2 40% | 0 0% | 0 0% |
| Subtotal | 148 | 57 39% | 39 26% | 25 17% | 27 18% |
| C. Aquifer Total | | | | | |
| Glacial | 115 | 37 32% | 41 36% | 25 22% | 12 10% |
| Magothy | 329 | 225 68% | 58 18% | 27 8% | 19 6% |
| Lloyd | 38 | 28 74% | 9 24% | 1 2% | 0 0% |
| Total | 482 | 290 60% | 108 22% | 53 11% | 31 6% |

Note: Based on the maximum level of any single organic chemical detected in the last sample at each well.

Source: Nassau County Department of Health

TABLE 1-2
VOLATILE ORGANIC LEVELS IN WELLS BY AQUIFER
NASSAU COUNTY, NEW YORK

Data Between July 1976 and September 30, 1984

| | <u>Wells Tested</u> | <u>None Detected</u> | <u><10 ug/l</u> | <u>>10 - <50 ug/l</u> | <u>>50 ug/l</u> |
|-------------------------|-------------------------|--------------------------|------------------------|---------------------------------|------------------------|
| A. Public Supply | | | | | |
| Glacial | 43 | 23 53% | 13 30% | 3 7% | 4 9% |
| Magothy | 348 | 241 69% | 69 20% | 31 9% | 7 2% |
| Lloyd | 43 | 34 79% | 8 19% | 1 2% | 0 0% |
| Subtotal | 434 | 298 69% | 90 21% | 35 8% | 11 3% |
| B. Monitoring | | | | | |
| Glacial | 283 | 83 29% | 89 31% | 68 24% | 43 15% |
| Magothy | 142 | 63 44% | 31 22% | 16 11% | 32 23% |
| Lloyd | 12 | 10 83% | 2 17% | 0 0% | 0 0% |
| Subtotal | 437 | 156 36% | 122 28% | 84 19% | 75 18% |
| C. Aquifer Total | | | | | |
| Glacial | 326 | 106 33% | 102 31% | 71 22% | 47 14% |
| Magothy | 490 | 304 62% | 100 20% | 47 10% | 39 8% |
| Lloyd | 55 | 44 80% | 10 18% | 1 2% | 0 0% |
| Total | 871 | 454 52% | 212 24% | 119 14% | 86 10% |

Note: Based on the maximum level of any single organic chemical detected in the last sample at each well.

Includes all wells tested since 1976 for volatile organics and BTX including abandoned wells.

Source: Nassau County Department of Health

2.0 DESCRIPTION OF MONITORING PROGRAM

2.1 Design and Installation of Monitoring Wells

Well drilling for this project consisted of the installation of two inch diameter "shallow" wells (53-62 feet deep) and four inch diameter "deep" wells (120-210 feet deep). The shallow wells were drilled to fifteen feet below the water table as estimated from existing data. Deep wells extended into deeper strata to monitor for downward migration of contaminants and to determine the vertical component of groundwater flow.

Well design specifications and construction supervision was provided by NCDH. All wells were installed and developed by Moretrench American Corporation. Each was finished to grade and furnished with a locking cast iron valve box. The elevation of the top of the casing was surveyed by the Nassau County Department of Public Works (mean sea level datum) and was used as the measuring point for water level readings.

Phase I wells are those installed between September 30, 1984 and December 3, 1984. Phase II wells were installed between August 13, 1985 and November 22, 1985. Table 2-1 lists all the wells installed as part of this project during each phase of drilling and their depths. Well survey diagrams are provided in Appendix C.

2.1.1 Drilling Methods

Wells less than 100 feet deep were drilled using the hollow stem auger method (eight-inch borehole). In most cases a wooden plug was used to cap the end of the auger to prevent soil from entering the hole. A head of potable water obtained from the local municipal water supply was kept in the auger to prevent soil from entering once the plug was removed by driving the casing. Well logs were recorded by examining soil taken from the auger flytes. Lithologic descriptions of these wells are provided in Appendix A.

Wells deeper than 100 feet were drilled using the mud rotary method (also eight-inch borehole) with a slurry composed of bentonite, potable water and "EZ Mud". Well logs were recorded using wash samples.

During Phase I of the well installation program, equipment was steam cleaned before beginning work at each of the five localities. During Phase II, the equipment was steam cleaned before drilling each well.

2.1.2 Well Construction

All wells were constructed with Schedule 80 flush joint threaded polyvinyl chloride (PVC) casing and screen (.020-inch horizontal slots) and provided with a vented PVC cap. Shallow wells were two-inch diameter PVC casing with ten feet of screen

TABLE 2-1
WELLS INSTALLED DURING EACH PHASE OF DRILLING

| Area | Phase I | | Phase II | |
|------------------|-------------|-------------|---|--------------|
| | Shallow | Deep | Shallow | Deep |
| New Cassel | NC-1 (60) | | NC-13 (68) | NC-2d (120) |
| | NC-2s (57) | | NC-14 (68) | NC-22d (125) |
| | NC-3 (60) | | NC-15 (66) | NC-26d (120) |
| | NC-4 (62) | | NC-16 (64) | NC-28d (130) |
| | NC-5 (67) | | NC-17 (64) | NC-29d (121) |
| | NC-6 (62) | | NC-18 (60) | NC-30d (118) |
| | NC-7 (57) | | NC-19 (62) | |
| | NC-8 (57) | | NC-20 (60) | |
| | NC-9 (59) | | NC-21 (63) | |
| | NC-10 (58) | | NC-23 (64) | |
| | NC-11 (58) | | NC-24 (65) | |
| | NC-12 (57) | | NC-25 (60) | |
| | | | NC-26s (62) | |
| | | | NC-27 (60) | |
| | | | NC-28s (57) | |
| | | | NC-29s (57) | |
| | | | NC-30s (40) | |
| Garden City Park | GCP-1 (55) | | GCP-3 (40) | |
| | GCP-2 (59) | | GCP-4 (61) | |
| | | | GCP-5 (59) | |
| | | | GCP-6 (55) | |
| | | | GCP-7 (65) | |
| | | | GCP-8 (60) | |
| | | | GCP-9 (61) | |
| New Hyde Park | NHP-1 (60) | | NHP-3 (50) (raised 12 ft. during Phase II) | |
| | NHP-2 (63) | | | |
| | NHP-3 (62) | | | |
| West Hicksville | WH-1 (60) | | | |
| | WH-2 (63) | | | |
| | WH-3 (64) | | | |
| | WH-4 (66) | | | |
| | WH-5 (72) | | | |
| | WH-6 (64) | | | |
| North Hicksville | NH-1s (116) | NH-1d (212) | | |
| | NH-2s (99) | NH-2d (210) | | |
| | NH-3s (105) | NH-3d (225) | | |

Note: s -shallow
d -deep
() -depth below ground surface

at the bottom. Deep wells were four-inch diameter PVC casing with twenty feet of screen at the bottom. Each well screen was packed with #1 well gravel.

Two seals, two to five feet in thickness were placed in each borehole: a lower seal just above the screen and an upper seal at or near the top of the well. Lower seals were bentonite pellets in the deep wells, and either bentonite pellets, 5% bentonite cement, or cement were in the shallow wells. Upper seals were cement and located a few feet below the valve box. A cement seal inside the valve box was used on several wells, however, these caused flooding of the valve box and were later broken to prevent such flooding. In these cases only the lower seal remains reliable. Additional seals were also placed at confining (clay) layers encountered during construction of deeper wells to prevent cross contamination of the formations. Wells with additional seals are identified in the well construction diagrams in Appendix B.

With the exception of Phase II deep wells, the drilling cuttings were used to backfill the annular space unless the cuttings were suspected to be contaminated with organic chemicals. A "HNU Photoanalyzer" was used to detect possible contamination of cuttings during drilling. If contamination was suspected, a fine mortar sand was used as backfill. Soil samples

were taken from the auger flytes at most wells and sent to the Nassau County laboratory for organic chemical analysis. Soil samples (wells) with detected organic compounds are identified in Table 3-3.

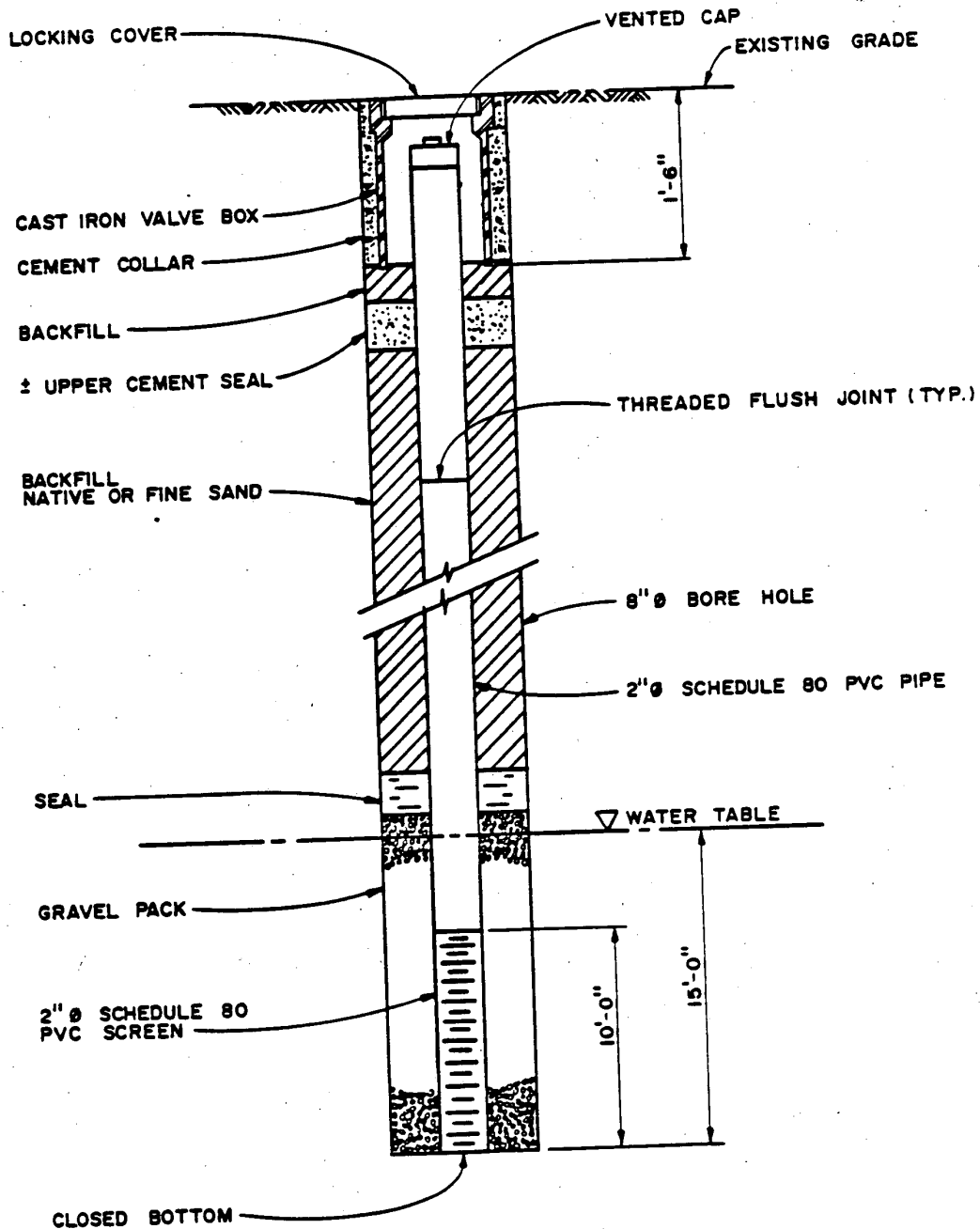
Because it is more likely to transfer contaminated soil from an upper portion of the aquifer to an area nearer to the screen in deep wells, all Phase II deep wells were backfilled with clean #1 gravel and no soil samples were analyzed for these wells. Gravel was used because of the anticipated difficulty in getting fine sand down through the bentonite mud.

Typical construction for the two-inch and four-inch wells are provided in Figures 2-1 and 2-2. Specific information for each well is detailed on the well completion diagrams in Appendix B.

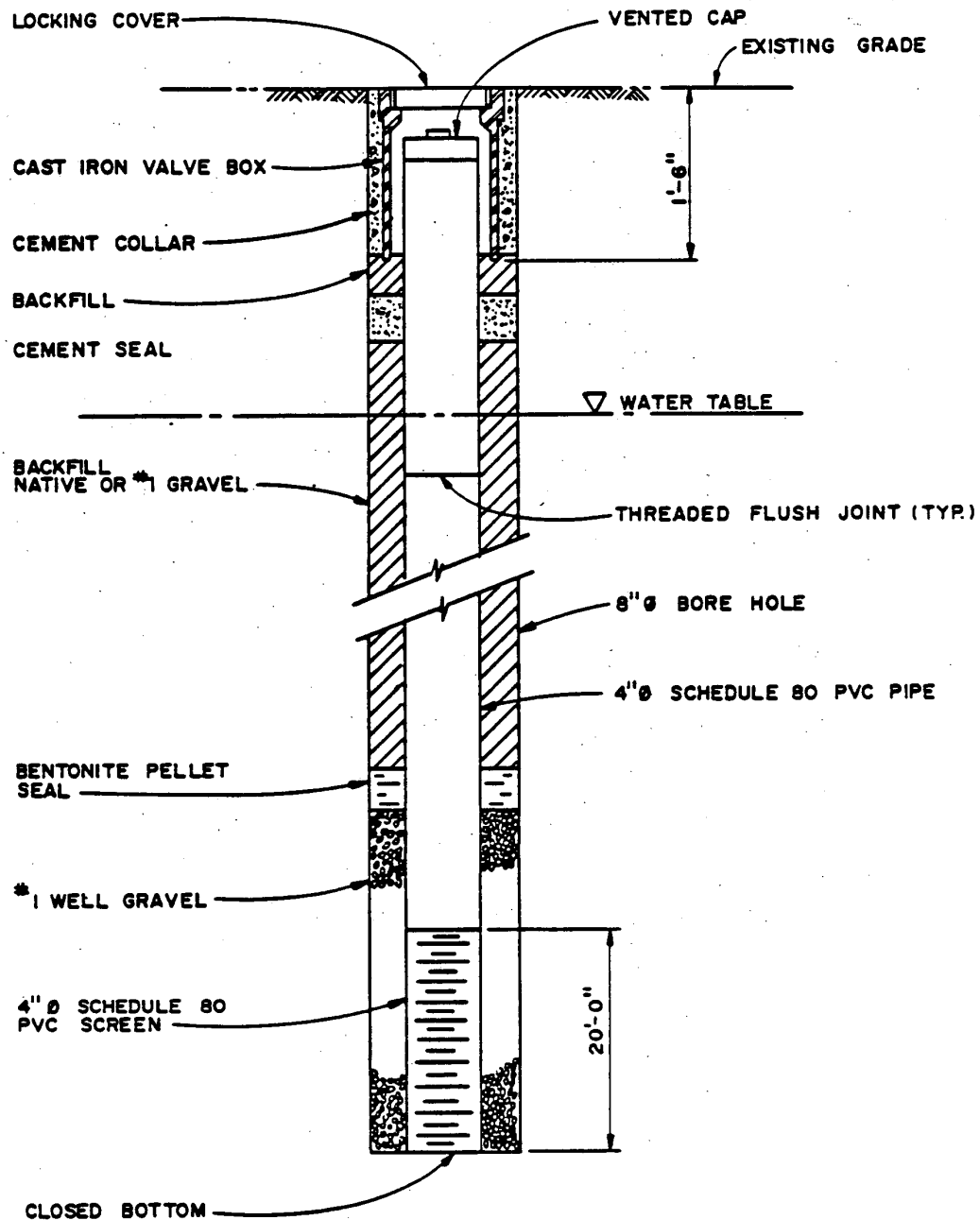
It should be noted that these wells were constructed to obtain only preliminary indications of water quality and potential sources at least cost because of budget limitations. Additional groundwater investigations at these identified areas should use standard monitoring well construction methods as recommended by USEPA or the New York State Department of Environmental Conservation (NYSDEC).

2.1.3 Well Development

Wells were developed by air-lift pumping and by jetting with potable water. Air-lift development (no compressor air line



WELL INSTALLATION
NO SCALE



WELL INSTALLATION
NO SCALE

filter was used) continued until little or no sand was visible in the discharge water and the flow of water appeared to have maximized. Most wells required one to two hours of air-lift development. Jetting was used at wells NC-28s, NC-26d and GCP-3. Wells were jetted with water when air lift pumping did not completely clear the screen. This occurred either because of excessive clay or hard pan in screened interval or because the screen was not completely below the water table. Equipment was steam cleaned before the development of each well.

2.2 Sampling and Analytical Procedures

All sampling and laboratory analyses were performed by Health Department personnel. During Phase I of the well drilling program at least several days lapsed between development and collection of the first samples, although some wells were sampled on the same day they were developed. During Phase II, several days lapsed in all cases. The construction logs in Appendix B indicate the date each well was developed. These can be compared with the sample dates given with the analytical results in Section 3.0.

2.2.1 Water Level Measurements

Water level readings were taken prior to sampling in order to determine the volume of water to be evacuated from each well. Water levels were obtained over the shortest time period possible

in order to use them as an indicator of flow direction. Water levels were recorded for each site within a day. Measurements were made using a steel tape marked with chalk and referenced to the top of the well casing. Water levels obtained during this study are provided in Tables 2-2 through 2-6.

2.2.2 Water and Soil Sampling

Standardized USEPA protocol was used for the collection of water and soil samples. Soil samples were collected in 40 milliliter (ml) glass containers with teflon septum seals. Water samples were collected in two 250 ml glass containers with teflon lined caps. The sample containers were collected and capped so as to minimize agitation and prevent the entrapment of air bubbles. All samples were stored in crushed ice until delivered to the laboratory where they were refrigerated immediately.

Shallow wells were evacuated and sampled with a top loading stainless steel bailer. Three water column volumes were removed prior to sample collection. The bailer was rinsed first with a dilute acetone solution and then with distilled water before use at each well.

Deep wells were evacuated and sampled with a three-inch submersible pump. The pump was not cleaned between wells, however, ten to twelve water column volumes were evacuated to purge the pump and tubing.

TABLE 2-2

WATER LEVEL MEASUREMENTS FROM NEW CASSEL MONITORING WELLS

March 13, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| NC-1 | 119.3 | 46.7 | 72.6 |
| NC-2s | 121.3 | 48.5 | 72.8 |
| NC-2d | 121.0 | 48.3 | 72.7 |
| NC-3 | 122.0 | 48.8 | 73.1 |
| NC-4 | 123.9 | 49.9 | 74.0 |
| NC-5 | 126.0 | 51.3 | 74.7 |
| NC-6 | 126.6 | 51.1 | 75.4 |
| NC-7 | 117.9 | 45.4 | 71.9 |
| NC-8 | 118.7 | 44.1 | 74.5 |
| NC-9 | 119.0 | 48.2 | 70.7 |
| NC-10 | 119.2 | --- | --- |
| NC-11 | 118.2 | 45.3 | 72.8 |
| NC-12 | 123.3 | 48.0 | 75.3 |
| NC-13 | 129.1 | 52.8 | 76.3 |
| NC-14 | 130.9 | 54.6 | 76.2 |
| NC-15 | 125.2 | 50.5 | 74.7 |
| NC-16 | 123.2 | 49.2 | 73.9 |
| NC-17 | 122.1 | 48.0 | 74.0 |
| NC-18 | 117.1 | 45.1 | 71.9 |
| NC-19 | 120.6 | 47.3 | 73.3 |
| NC-20 | 117.6 | 45.5 | 72.1 |
| NC-21 | 125.1 | 50.9 | 74.1 |
| NC-22d | 124.9 | 50.2 | 74.6 |
| NC-23 | 122.8 | 48.4 | 74.3 |
| NC-24 | 119.9 | 46.8 | 73.1 |
| NC-25 | 118.9 | 45.3 | 73.5 |
| NC-26s | 112.9 | 41.2 | 71.8 |
| NC-26d | 111.4 | 39.0 | 72.3 |
| NC-27 | 117.6 | 44.0 | 73.6 |
| NC-28s | 110.4 | 44.3 | 66.0 |
| NC-28d | 110.8 | 42.0 | 68.7 |
| NC-29s | 111.4 | 41.5 | 69.8 |
| NC-29d | 111.3 | 41.6 | 69.7 |
| NC-30s | 93.4 | 25.5 | 67.8 |
| NC-30d | 93.1 | 25.2 | 67.8 |

TABLE 2-2
(continued)

WATER LEVEL MEASUREMENTS FROM NEW CASSEL MONITORING WELLS

March 10, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| NC-1 | 119.3 | 46.6 | 72.6 |
| NC-3 | 122.0 | 48.6 | 73.3 |
| NC-4 | 123.9 | 49.8 | 74.1 |
| NC-7 | 117.9 | 45.3 | 72.5 |
| NC-8 | 118.7 | 46.6 | 72.1 |
| NC-9 | 119.0 | 48.1 | 70.7 |
| NC-10 | 119.2 | 46.9 | 72.3 |
| NC-11 | 118.2 | 45.2 | 72.0 |
| NC-12 | 123.3 | 48.8 | 74.4 |

WATER LEVEL MEASUREMENTS FROM NEW CASSEL MONITORING WELLS

March 7, 1986

| <u>Well Number</u> | <u>Elevation (feet above mean sea level)</u> | <u>Water (feet below measuring point)</u> | <u>Elevation (feet above mean sea level)</u> |
|------------------------|--|---|--|
| NC-5 | 126.0 | 51.2 | 74.8 |
| NC-6 | 126.6 | 51.0 | 75.6 |
| NC-13 | 129.1 | 53.6 | 75.5 |
| NC-17 | 122.1 | 48.3 | 73.7 |
| NC-22 | 124.9 | 50.5 | 74.3 |
| NC-24 | 119.9 | 46.6 | 73.3 |
| NC-25 | 118.9 | 45.1 | 73.7 |
| NC-26s | 112.9 | 39.5 | 73.5 |
| NC-26d | 111.4 | 40.8 | 70.6 |
| NC-27 | 117.6 | 43.8 | 73.8 |
| NC-28d | 110.8 | 41.9 | 68.9 |
| NC-30s | 93.4 | 25.4 | 68.0 |
| NC-30d | 93.1 | 25.1 | 68.0 |

TABLE 2-2
(continued)

WATER LEVEL MEASUREMENTS FROM NEW CASSEL MONITORING WELLS

March 5, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| NC-2d | 121.0 | 48.1 | 72.9 |
| NC-14 | 130.9 | 54.4 | 76.4 |
| NC-15 | 125.2 | 50.3 | 74.8 |
| NC-16 | 123.2 | 49.1 | 74.1 |
| NC-18 | 117.1 | 45.0 | 72.0 |
| NC-19 | 120.6 | 47.8 | 72.7 |
| NC-20 | 117.6 | 45.7 | 71.9 |
| NC-21 | 125.1 | 50.8 | 74.3 |
| NC-23 | 122.8 | 48.3 | 74.4 |
| NC-29s | 111.4 | 41.5 | 69.9 |
| NC-29d | 111.3 | 41.5 | 69.8 |

WATER LEVEL MEASUREMENTS FROM NEW CASSEL MONITORING WELLS

August 5, 1984

| <u>Well Number</u> | <u>Elevation (feet above mean sea level)</u> | <u>Water (feet below measuring point)</u> | <u>Elevation (feet above mean sea level)</u> |
|------------------------|--|---|--|
| NC-1 | 119.3 | 44.3 | 75.0 |
| NC-2s | 121.3 | 45.9 | 75.4 |
| NC-3 | 122.0 | 46.2 | 75.8 |
| NC-14 | 123.9 | 46.7 | 77.2 |
| NC-25 | 126.0 | 47.9 | 78.1 |
| NC-26 | 126.6 | 47.7 | 78.9 |
| NC-27 | 117.9 | 43.3 | 74.6 |
| NC-28s | 118.7 | 44.6 | 74.1 |
| NC-29d | 119.0 | 44.4 | 74.6 |

TABLE 2-3

WATER LEVEL MEASUREMENTS FROM GARDEN CITY PARK MONITORING WELLS

March 11, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| GCP-1 | 89.4 | 41.7 | 47.7 |
| GCP-2 | 100.7 | 50.7 | 49.9 |
| GCP-3 | 88.6 | 37.4 | 51.1 |
| GCP-5 | 94.8 | 45.6 | 49.1 |
| GCP-6 | 95.4 | 46.0 | 49.4 |
| GCP-7 | 98.5 | 51.1 | 47.4 |
| GCP-8 | 94.8 | 47.3 | 47.5 |
| GCP-9 | 92.8 | 44.4 | 48.3 |

TABLE 2-4

WATER LEVEL MEASUREMENTS FROM NEW HYDE PARK MONITORING WELLS

March 11, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| NHP-1 | 79.0 | 31.6 | 47.4 |
| NHP-2 | 96.8 | 52.4 | 44.4 |
| NHP-3 | 78.6 | 34.0 | 44.6 |

TABLE 2-5

WATER LEVEL MEASUREMENTS FROM WEST HICKSVILLE MONITORING WELLS

March 10, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| WH-1 | 125.4 | 48.9 | 76.4 |
| WH-2 | 130.9 | 54.8 | 76.1 |
| WH-3 | 139.7 | 53.7 | 86.0 |
| WH-4 | 133.7 | 56.5 | 77.1 |
| WH-5 | 134.9 | 57.3 | 77.5 |

TABLE 2-6

WATER LEVEL MEASUREMENTS FROM NORTH HICKSVILLE MONITORING WELLS

March 11, 1986

| <u>Well Number</u> | <u>Measuring Point Elevation (feet above mean sea level)</u> | <u>Depth to Water (feet below measuring point)</u> | <u>Water-Level Elevation (feet above mean sea level)</u> |
|------------------------|--|--|--|
| NH-1s | 172.5 | 11.5 | 100.9 |
| NH-1d | 172.4 | 85.1 | 87.2 |
| NH-2s | 166.2 | 84.1 | 82.1 |
| NH-2d | 166.6 | 84.9 | 81.6 |
| NH-3s | 163.4 | 83.1 | 80.3 |
| NH-3d | 163.7 | 83.9 | 79.8 |

2.3 Analytical Procedures

All samples were analyzed by the Nassau County Department of Health Environmental Laboratory. Of the two 250 ml water samples, one was analyzed and the second was retained in reserve.

The analytical methods utilized for soil and water samples was a combination of USEPA method 624 and the New York State Department of Health approved method. A summary of the procedure used is as follows:

- Purge and trap onto poropak N adsorption tube.
- Methanol elution of adsorption tube.
- Analysis of effluent by capillary gas chromatography using an effluent splitter for dual detection by photoionization (volatile aromatic hydrocarbons) and electron capture detectors (volatile halogenated hydrocarbons)*

Quality Assurance and Quality Control (QA/QC) practices used for these procedures are taken from references 2 and 4.

The following areas of QA/QC were (and are routinely) addressed by the County Laboratory's Quality Assurance Program.

*Prior to January 8, 1985, the photoionization and electron capture detector analyses were performed separately.

- Documentation of day-to-day instrument performance.
- Records of instrument calibrations.
- Preparation of daily control charts.
- Records of personnel accountability to demonstrate chain of custody.
- Periodic laboratory replicate analyses.
- Regular use of laboratory blanks.
- Periodic recovery of standards by the method of standard additions
- Regular participation in proficiency programs sponsored by regulatory agencies and consultants.
- Regular participation in inter-laboratory splitting of reference samples.
- Records of precision and accuracy.
- Records of instrument repair and preventative maintenance.
- Regular monitoring of reagent quality.
- Records establishing the quality of reconditioned adsorption tubes.

Although formal chain of custody records were not kept, all field and laboratory personnel were accountable by signature for all work that they completed. Records were maintained so that all work functions could be traced back to the responsible individual. A "log-in" and tracking procedure was in place for all sample containers.

3.0 MONITORING PROGRAM RESULTS

3.1 Methodology for Site-Specific Assessment

This monitoring program provides a preliminary determination of the extent of groundwater contamination in the five sites investigated as part of this study. This assessment is preliminary for several reasons. First, common to most studies only a small fraction of the groundwater is actually sampled. Second, there is always an unquantifiable difference between measured and actual groundwater conditions. Third, the construction of the local groundwater flow regimes is not based on long term groundwater level measurements and therefore for some of the areas, the most likely direction of contaminant movement is not well defined. Finally, the apparent variability in the analytical results from many of the same sampling points (originating from natural variability in water quality, sampling closely following development, erratic input of contaminants, sampling error and/or error in chemical analyses) has placed constraints in data evaluation.

The approach taken in the data evaluation was to discard the first analytical result for each of the wells installed during the study. It was felt that this sample may not be representative because in many cases it was taken shortly after well development and was possibly being influenced by the methods

used in development. The water quality mapping for total organic compounds detected at each site was constructed based on the mean value. However, most mean values have an associated relatively large standard deviation indicating that the data are not consistent. In wells that seem to have increasing concentrations, this approach may not be valid. However, the data are not adequate to assess increasing or decreasing trends.

For each of the five selected areas, the site specific hydrogeology is assessed to the extent possible using static water level information and lithology obtained from well logs during construction of the monitoring wells. In addition, existing wells in each area (both water supply and monitoring) were also used in defining geologic and hydrologic conditions and supplementing the water quality data. Tentative boundaries between the glacial and Magothy aquifers based on the above information were not field verified, and thus can only be considered preliminary estimate.

Because land use in an area can have a direct effect on water quality, a site description is provided for each area. Land use is discussed from both a historical perspective as well as a current industrial profile.

Based on the above information, a preliminary assessment of water quality is made with respect to the extent of contamina-

tion and the threat to water supply, as well as general areas of contaminant sources. Water quality contouring of major contaminants is developed with special attention to potential source areas.

3.2 New Cassel

3.2.1 Site Description

New Cassel, shown in Figure 3-1, is an almost triangular shaped portion in the Town of North Hempstead with a total area of about three square miles. The northern borders are Brush Hollow Road east of Westbury and Cantiague Lane. The southern border is Old Country Road north of Bowling Green in the Town of Hempstead.

Most of the wells drilled as part of this study are located in the southern part of New Cassel near Railroad Avenue and north of Old Country Road between Grand Boulevard and Wantagh State Parkway. Three wells are located just north of Railroad Avenue and five wells are located south of Old Country Road in Bowling Green. Well locations are shown in Figure 3-2. This Figure also shows land use in the area.

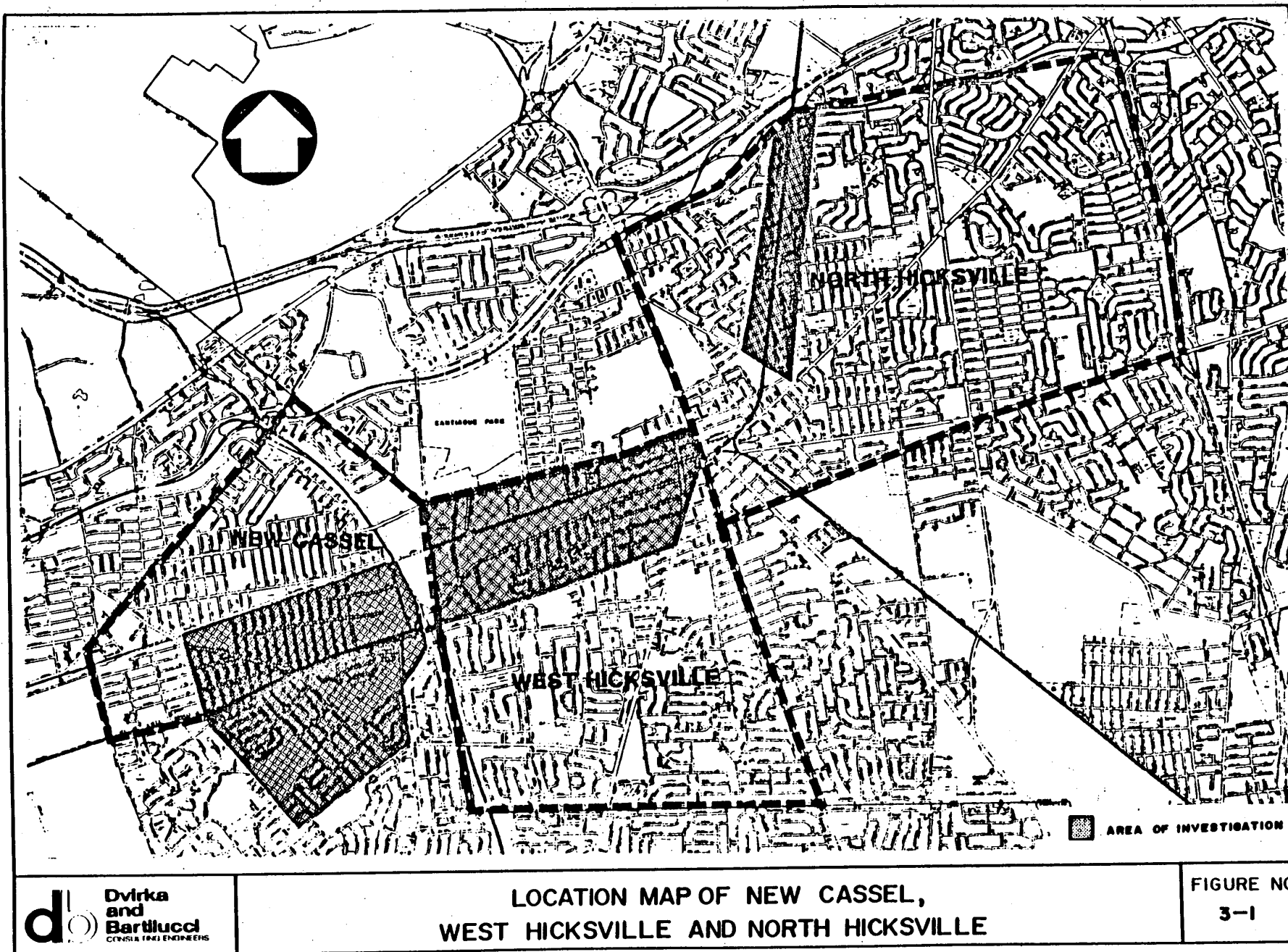
The major land uses are residential, industrial, commercial and institutional. The residential area, located in the northern and southwestern part of New Cassel is of medium density with five to ten dwelling units per acre. Institutions (such as

schools) are located within the residential areas. Commercial activity is concentrated on elongated strips along Prospect Avenue and along Old Country Road. Intensive industrial activity is concentrated between the Long Island Railroad and Old Country Road and north of the railroad west of Grand Avenue.

The area is serviced by the Town of North Hempstead Westbury Water District. New Cassel is part of Nassau County Sewage Disposal District #3 and the industrial area has been sewered since 1979. The area was developed about 30 to 40 years ago and growth since that time has been marginal. The 1980 population was 9,635, an increase of about 900 from 1970.

There are no known active or former landfills in New Cassel, however, there is a municipal landfill owned by the New York State Department of Parks and Recreation adjacent to the area on Duffy Avenue in Hicksville that accepts agricultural wastes, leaves, street sweepings and rubbish. There is also a former landfill on West John Street, east of Charlotte Street in Hicksville.

According to the Nassau County Department of Health, the only documented occurrence of groundwater contamination (prior to 1977) is from Jarco Metal Products Corporation located on Grand Avenue south of the railroad tracks. From at least 1952 to 1964, wastes were discharged directly into settling lagoons and cess-





NEW CASSEL
WELL LOCATION AND IDENTIFICATION

FIGURE NO.
3-2

pools. The groundwater was found to be contaminated with cyanide and hexavalent chromium. The contribution of this firm to contamination by organic compounds is unknown because organic chemical usage is not available and analytical methods were not developed until the mid 1970's to determine the presence of synthetic organics in water.

Information on the current industrial profile of New Cassel indicates that the area is heavily industrialized with a wide variety of industrial categories, including chemical, electrical, plastics and steel production facilities. Table 3-1 provides an industrial profile of the area from 1977 to 1985 and estimates annual organic chemical usage.

There are a number of facilities listed under either State Pollutant Discharge Elimination System (SPDES) discharge permit or NYS Part 360 permit. Known SPDES violations due to spills, illegal disposal of hazardous wastes or other violations are summarized below:

- o Drum spill on June 7, 1984 (estimated to be 30-40 gallons of solvent) at 806 Oliver Avenue. Analyses of the drum material reported to be 1,1,2-trichloroethane at 2,000 ppm and 1,1,1-trichloroethane at 10,000 ppm.

- o Tishcon Corporation - two reported spills on September 19, 1984
off Brooklyn Avenue between Old Country Road and Main Street
 - 30 to 40 gallons of bright pink liquid
 - unknown white liquid around drywell

Analyses reported to be 1,1,1-trichloroethane at 6,500 ppb,
1,1-dichloroethane at 450 ppb and trichloroethylene at 34 ppb.
(This site has been cleaned up.)

- o Royal Athletic Supply Company - 120 Hopper St. - Complaint on
November 29, 1979 about washing out 55 gallon drums in the
street. The material is unknown.

3.2.2 Geology

The study wells in New Cassel tap the glacial and the
upper Magothy aquifer. A hydrogeologic cross section is shown in
Figure 3-3.

The upper glacial formation consists mainly of sand and
gravel deposits with some cobbles in an unstratified mixture.
The upper glacial aquifer is about 50 feet thick in the New
Cassel area. This correlates with United States Geological
Survey (USGS) information for this area.

The Magothy aquifer consists mainly of fine to medium sand
with traces of silt and clay. The top of the Magothy is found at
approximately 50 feet below the surface in New Cassel. Although
scattered clay layers exist, the layers are not continuous in
these wells, even at distances as close as 400 feet apart.

TABLE 3-1

INDUSTRIAL PROFILE OF NEW CASSEL

Source: NCHD Industrial Survey Program

| <u>Name</u> | <u>Location</u> | <u>Organic Chemicals Used</u> | <u>Amount Used, Stored, Disposed, etc. Since 1977</u> |
|---------------------------------|------------------|--|---|
| Duramed Pharmaceuticals | 72 Sylvester St. | 1,1,1 trichloroethane Methylene chloride | 1 drum 1 drum |
| Custom Coatings Inc. | 36 New York Ave. | Methylene chloride Chloroethene | 200 gals/yr 200 gals/yr |
| Avanel Industries Inc. | 121 Hopper St. | 1,1,1 trichloroethane | 35 gals/yr |
| Advance Food Service Eqpt. | 750 Summa Ave. | 1,1,1 trichloroethane | 330 gals/yr |
| Perma Fuse Corp. | 675 Main St. | 1,1,1 trichloroethane Toluene Kerosene | 200 gals/yr 2000 gals/yr 600 gals/yr |
| Hamilton Avnet Electronics Inc. | 70 State St. | Trichloroethylene Methyl ethyl ketone | 55 gals/yr 300 gals/yr |
| Autronics Plastics | 18 Sylvester St. | Toluene | 120 gals/yr |
| Kwik-Eeze Corp. | 54 Brooklyn Ave. | 1,1,1 trichloroethane Toluene | 1 gal/yr 1 gal/yr |

TABLE 3-1 (continued)

INDUSTRIAL PROFILE OF NEW CASSEL

Source: NCHD Industrial Survey Program

| <u>Name</u> | <u>Location</u> | <u>Organic Chemicals Used</u> | <u>Amount Used Stored, Disposed, etc. Since 1977</u> |
|------------------------------|------------------|---|--|
| LAKA Industry Inc. | 62 Kinkel St. | Trichloroethylene | 55 gals/yr |
| Holmes & Sons Inc. | 84 New York Ave. | Methylene chloride | 165 gals/yr |
| Warren Machine Co. | 117 Urban Ave. | Methyl ethyl ketone | 25 gals/yr |
| Molla Inc. | 110 State St. | Paint thinner | 2000 gals/yr |
| Bernite Products Inc. | 84 New York Ave. | Methylene chloride Tetrachloroethylene | 2000 gals/yr 500 gals/yr |
| Guillotine Splicer Co. | 45 Urban Ave. | 1,1,1 trichloroethane | 12 gals/yr |
| Anthonsen's All Metal Prods. | 630-640 Main St. | Methyl ethyl ketone | 200 gals/yr |
| Sew Simple Inc. | 115 Frost St. | Ink | 300 gals/yr |
| Alltronics | 45 Bond St. | Trichloroethane | 600 gals/yr |

TABLE 3-1 (continued)

INDUSTRIAL PROFILE OF NEW CASSEL

Source: NCHD Industrial Survey Program

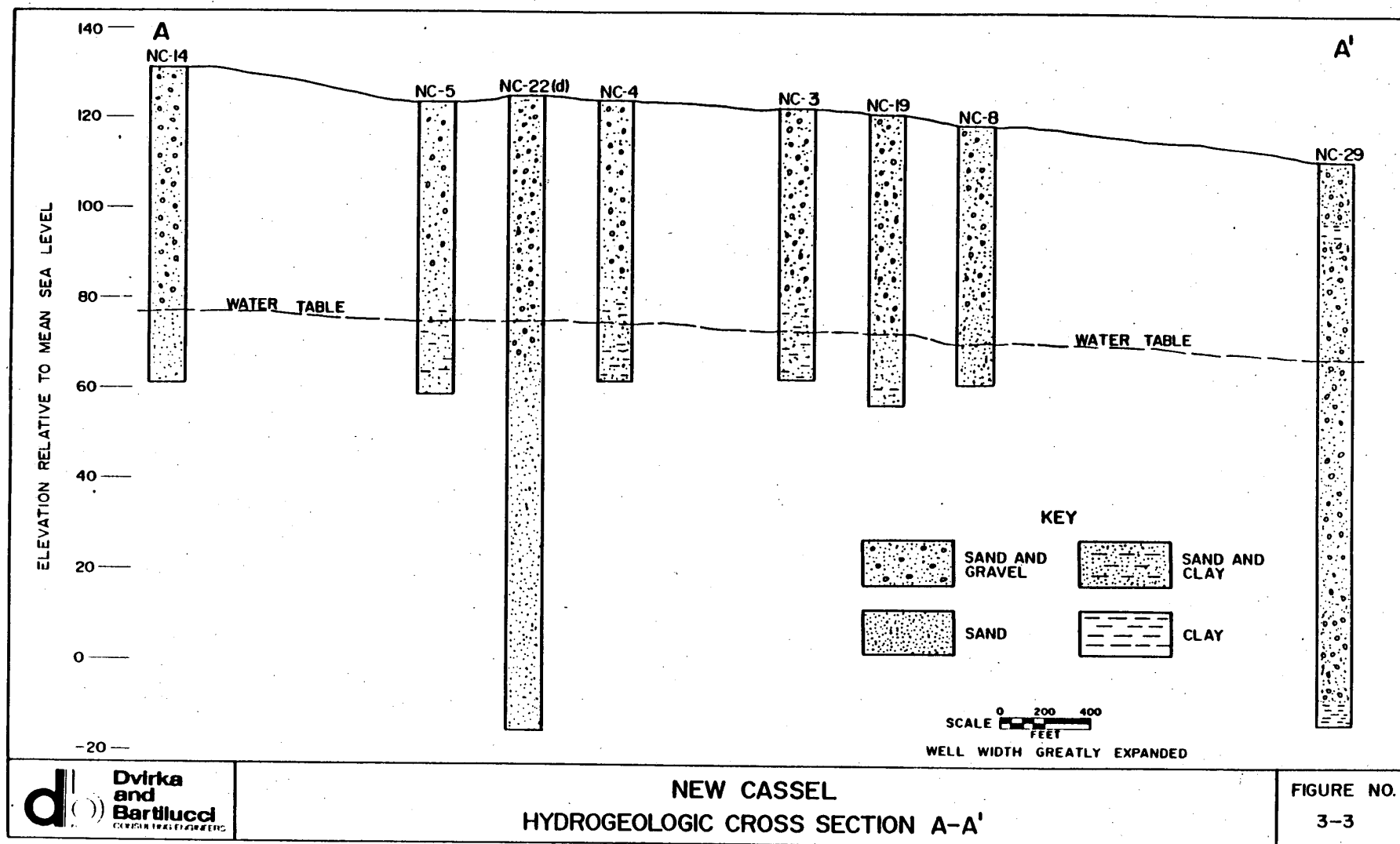
| <u>Name</u> | <u>Location</u> | <u>Organic Chemicals Used</u> | <u>Amount Used, Stored, Disposed, etc. Since 1977</u> |
|-----------------------------|----------------------------------|--|---|
| Arkwin Industries Inc. | 686 Main St. | 1,1,1 trichloroethane Methyl ethyl ketone | 4500 gals/yr 110 gals/yr |
| Atlas Graphics Inc. | 567 Main St. | Trichloroethylene | 312 gals/yr |
| Adchem Corp. | 625 Main St. 85 New York Ave. | Toluene Methyl ethyl ketone | 30,000 lbs/yr 30,000 lbs/yr |
| Bilt-Rite Steel Buck. Corp. | 95 Hopper St. | Xylene | 670 gals/yr |
| Dionics Inc. | 65 Rushmore St. | Trichloroethylene Xylene | 1000 gals/yr 100 gals/yr |
| Herbert Products Inc. | 180 Linden Ave. | 1,1,1 trichloroethane | 4 gals/yr |
| Huron Tool & Cutting | 75 State St. | Trichloroethane | 20 gals/yr |
| IMC Magnets Corp. | 570 Main St. | Tetrachloroethylene Methyl ethyl ketone Xylene | 600 gals/yr 25 gals/yr 120 gals/yr |

TABLE 3-1 (continued)

INDUSTRIAL PROFILE OF NEW CASSEL

Source: NCHD Industrial Survey Program

| <u>Name</u> | <u>Location</u> | <u>Organic Chemicals Used</u> | <u>Amount Used, Stored, Disposed, etc. Since 1977</u> |
|-------------------------------|------------------|--|---|
| International Ribbon & Carbon | 49 Sylvester St. | 1,1,1 trichloroethane | 500 gals/yr |
| Island Transportation Corp. | 299 Main St. | Trichloroethylene | 80 gals/yr |
| Kaeonicks Inc. | 700 Summa Ave. | 1,1,1 trichloroethane | 5-10 gals/yr |
| Westly Displays Inc. | 589 Main St. | Toluol | 10 gals/yr |
| Utility Mfg. Co. | 700 Main St. | Trichloroethane | 1500 gals/yr |
| Applied Fluids | 770 Main St. | Methyl ethyl ketone Trichloroethylene | 10 gals/yr 10 gals/yr |
| Parfuse Corp. | 65 Kinkel St. | Tetrachloroethylene | 55 gals/yr |



3.2.3 Hydrology

Regional groundwater flow direction in the New Cassel area is towards the southwest. This regional flow regime is evident in water level measurements taken from the New Cassel study wells, where water levels are found to be 76 feet above mean sea level in the northern area versus levels as low as 66 feet above mean sea level in the southwest. The contoured water levels for this area (Figure 3-4) show at least two modifications to the regional flow regime. Based on all available water level measurements and a resurvey of well elevations, well NC-12 is situated on what may be a local groundwater mound. NC-8 may also be a local mound, however, only the most recent reading indicates the slightly higher water level for NC-8. Well NC-9 may be a local water table depression. This lower water level is consistent with other reported values for the past year. These local perturbations to the groundwater regime may be the result of unknown pumping and recharge in New Cassel, or a survey error.

With regard to vertical flow in the New Cassel area, the static water levels in the shallow and deep cluster wells are not consistent. NC-2 did not demonstrate any appreciable difference in water levels between the shallow and deep wells. Well NC-26 showed a downgradient component of flow in the most recent reading, however, in a previous reading, the situation is reversed

into an apparent groundwater upwelling based on the static water level measurements. In NC-28 where only one set of water level measurements are available, there is an apparent downward component of groundwater flow.

Although a determination of recharge/discharge characteristics cannot be inferred due to the data inconsistency obtained in this study, on a regional scale, New Cassel is in the deep recharge zone. Because the glacial and Magothy aquifers are hydraulically connected, contamination in the glacial aquifer is likely to migrate into the Magothy.

Additional data is necessary to determine an accurate and consistent picture of the local groundwater flow regime in this area.

3.2.4 Analytical Results and Findings

A total of 35 wells were installed in the New Cassel area as part of this groundwater investigation. The wells were sampled one to three times from December 1984 to February 1986. Seventeen of the 35 wells sampled as part of the New Cassel groundwater investigation exceed New York State guidelines for organic compounds in drinking water as do three existing wells in the area. One additional well also exceeds proposed Federal maximum limits for drinking water.

Analytical results are shown in Table 3-2 and total organic compounds are summarized in Table 3-3. A graphic representation of analytical results for total organic compounds is shown in Figure 3-5.

Wells exhibiting significant contamination with mean values greater than 1000 ug/l of total organic compounds are NC-2s (2,927 ug/l); NC-7 (3,150 ug/l); NC-21 (1,023 ug/l); NC-25 (1,822 ug/l); N7732 (2,726 ug/l); and N9938 (9,800 ug/l). These wells are less than 2,400 feet from each other, and some are as close as 400 feet.

Principal contaminants in these wells are 1,1,1-trichloroethane; tetrachloroethylene; trichloroethylene; 1,1-dichloroethane; and (analyzed jointly) methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene.

These heavily contaminated wells are typically about 60 feet deep, however, two wells are deeper: N9938 is 80 feet deep and N7732 is 108 feet deep.

There are 12 wells with total organic compounds between 100 and 1000 ug/l:

| <u>Well No.</u> | <u>Total Organic Compounds (ug/l)</u> |
|-----------------|---|
| NC-2d | 797 |
| NC-4 | 503 |
| NC-8 | 714 |
| NC-9 | 532 |
| NC-11 | 206 |
| NC-19 | 112 |
| NC-20 | 401 |
| NC-23 | 127 |
| NC-24 | 735 |
| NC-27 | 344 |
| NC-29s | 873 |

Principal contaminants are 1,1,1-trichloroethane; tetrachloroethylene; trichloroethylene; chloroform; cis and trans-1,2-dichloroethylene; and (analyzed together) methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene.

These wells are also less than 4,000 feet from each other and some are as close as 400 feet.

There are seven wells with concentrations of total organic compounds between 10 and 100 ug/l:

| <u>Well Number</u> | <u>Total Organic Compounds (ug/l)</u> |
|--------------------|---|
| NC-3 | 35 |
| NC-5 | 15 |
| NC-16 | 16 |
| NC-26s | 14 |
| NC-26d | 22 |
| NC-29d | 48 |
| NC-30d | 27 |

The principal contaminants are tetrachloroethylene; 1,1,1-trichloroethane; trichloroethylene; and (analyzed jointly) methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene. Four of these wells are about 65 feet deep, and three are about 120 feet deep.

Sixteen wells had non-detected to 10 ug/l of total organic compounds. Seven of these had no reported concentrations above the detection limit: NC-6; NC-14; NC-28s; N6819; N8497; N8956; and N8957. Three of these wells are about sixty feet deep; the remaining three are greater than 500 feet deep. One of these

TABLE 3-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-1 | NC-1 | NC-1 | NC-2s | NC-2s | NC-2s | NC-2s | NC-2s | NC-2s | NC-2d | NC-2d | NC-3 | NC-3 |
|-----------------------------------|---------|---------|----------|----------|---------|---------|---------|----------|---------|----------|---------|---------|---------|
| WELL DEPTH----- | 60 | 60 | 60 | 57 | 57 | 57 | 57 | 57 | 57 | 120 | 120 | 60 | 60 |
| SAMPLE DATE----- | 12/4/84 | 3/26/85 | 12/27/85 | 10/16/84 | 12/4/84 | 3/13/85 | 3/26/85 | 12/27/85 | 1/31/86 | 11/25/85 | 1/31/86 | 12/4/84 | 3/13/85 |
| Trichlorofluoroethane----- | <1 | <1 | NA | <3 | <1 | <1 | <1 | NA | NA | NA | NA | <1 | <1 |
| Methylene Chloride----- | <10 | <4 | <8 | 10 | 14 | 11 | 11 | <8 | 24 | <8 | 310 | <10 | <4 |
| 1,1,2-Trichlorotrifluoroethane--) | | | | | | | | | | | | | |
| 1,1-Dichloroethylene----- | <15 | | <14 | <10 | <15 | | <20 | 17 | 22 | NR | <10 | <15 | |
| c & t-1,2-Dichloroethylene----- | | | | | | | | | | | | | |
| t-1,2-Dichloroethylene----- | | <5 | | | | <5 | | | | | | | <5 |
| 1,1-Dichloroethane----- | <15 | NA | <14 | <15 | <15 | NA | NA | <14 | <12 | NR | 71 | <15 | NA |
| c-1,2-Dichloroethylene----- | | <20 | | | | <20 | | | | | | | <20 |
| Chloroform----- | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 2 | 2 | <1 | <1 |
| 1,1,1-Trichloroethane----- | <1 | <1 | 1 | 69 | 40 | 130 | 150 | 390 | 560 | 430 | 260 | 2 | 3 |
| Carbon Tetrachloride----- | <1 | <1 | <1 | <1 | <1 | NR | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Trichloroethylene----- | <1 | <1 | <1 | 190 | 1300 | 2100 | 2300 | 2200 | 1500 | 68 | 64 | <1 | 3 |
| Bromodichloroethane----- | <1 | <1 | <1 | <3 | <10 | NR | NR | <1 | <1 | <1 | <1 | <1 | <1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | <2 | | | <2 | <2 | | | | | | | <2 | |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| c-1,3 Dichloropropene-----) | | <1 | <1 | | | <1 | <1 | <1 | <1 | <1 | <1 | | <1 |
| Dibromochloroethane-----) | | <2 | <1 | | | 2 | 2 | NR | 1 | <1 | <1 | | <2 |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| 1,2-Dibromoethane----- | <6 | <2 | NA | <10 | <60 | NR | NR | NA | NA | NA | NA | <6 | <2 |
| Tetrachloroethylene----- | <1 | 1 | 2 | 62 | 1200 | 420 | 470 | 950 | 2200 | 41 | 90 | 16 | 39 |
| Bromoform----- | <3 | <1 | <2 | <6 | <3 | <1 | <1 | <2 | <1 | <2 | <1 | <3 | <1 |
| Benzene----- | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | NA | <3 | <3 | <3 |
| Toluene----- | <3 | <4 | <6 | <3 | <3 | <4 | <4 | <6 | <4 | NA | <4 | <3 | <3 |
| Chlorobenzene----- | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <4 | NA | <4 | <3 | <3 |
| Ethylbenzene----- | <3 | <3 | <6 | <3 | <3 | NR | NR | <6 | <4 | NA | <4 | <3 | <3 |
| Xylene (o,s,p)----- | <3 | <3 | <6 | <3 | <3 | <10 | <3 | <6 | <5 | NA | <5 | <3 | <3 |
| Dichlorobenzene (o,s,p)----- | <5 | <4 | <9 | <6 | <5 | <3 | <4 | <9 | <9 | NA | <9 | <5 | <4 |
| Total----- | 0 | 1 | 3 | 931 | 2554 | 2663 | 2933 | 3557 | 4307 | 541 | 797 | 18 | 45 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

7-No Mention On Lab Results

TABLE 3-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-3 | NC-4 | NC-4 | NC-4 | NC-5 | NC-5 | NC-5 | NC-6 | NC-6 | NC-6 | NC-7 | NC-7 | NC-7 |
|-----------------------------------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|
| WELL DEPTH----- | 60 | 62 | 62 | 62 | 67 | 67 | 67 | 62 | 62 | 62 | 57 | 57 | 57 |
| SAMPLE DATE----- | 12/26/85 | 12/4/84 | 9/25/85 | 12/24/85 | 12/4/85 | 9/25/85 | 12/24/85 | 12/4/84 | 9/26/85 | 12/24/85 | 12/4/84 | 2/28/85 | 12/27/85 |
| Trichlorofluoroethane----- | NA | (1 | (1 | NA | (1 | (1 | NA | (1 | (1 | NA | (1 | (1 | NA |
| Methylene Chloride-----) | | | | | | | | | | | | | |
| 1,1,2-Trichlorotrifluoroethane--) | (8 | (10 | 6 | (8 | (10 | (4 | (8 | (10 | (4 | (8 | (10 | (7 | 60 |
| 1,1-Dichloroethylene-----) | | | | | | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | (14 | (15 | | (14 | (15 | | (14 | (15 | | (14 | (15 | | (14 |
| t-1,2-Dichloroethylene----- | | | (5 | | | (5 | | | (5 | | | (7 | |
| 1,1-Dichloroethane----- | (14 | (15 | NA | (14 | (15 | NA | (14 | (15 | NA | (14 | 170 | NA | 1300 |
| c-1,2-Dichloroethylene----- | | | (20 | | | (20 | | | (20 | | | 7 | |
| Chloroform----- | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 |
| 1,1,1-Trichloroethane----- | 2 | 3 | 30 | 490 | 8 | 5 | 2 | (1 | (1 | (1 | 420 | 510 | 4400 |
| Carbon Tetrachloride----- | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (10 | (10 | (1 |
| Trichloroethylene----- | 1 | 160 | 150 | 270 | 14 | 7 | 1 | (1 | (1 | (1 | (10 | 4 | 10 |
| Bromodichloroethane----- | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | | (2 | | | (2 | | | (2 | | | (2 | | |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| c-1,3 Dichloropropene-----) | | | (1 | (1 | | (1 | (1 | | (1 | (1 | | (1 | (1 |
| Dibromochloroethane-----) | (1 | | (2 | (1 | | (2 | (1 | | (2 | (1 | | (2 | 2 |
| 1,1,2-Trichloroethane----- | (1 | | | | | | | | | | | | |
| 1,2-Dibromoethane----- | NA | (4 | (2 | NA | (4 | (2 | NA | (4 | (2 | NA | (4 | (2 | NA |
| Tetrachloroethylene----- | 21 | 2 | 2 | 58 | 13 | 10 | 5 | (1 | (1 | (1 | 1 | 4 | 10 |
| Bromoform----- | (2 | (3 | (1 | (2 | (3 | (1 | (2 | (3 | (1 | (2 | (3 | (1 | (2 |
| Benzene----- | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 |
| Toluene----- | (4 | (3 | (4 | (4 | (3 | (4 | (4 | (3 | (4 | (4 | (3 | (4 | (4 |
| Chlorobenzene----- | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 |
| Ethylbenzene----- | (4 | (3 | (3 | (4 | (3 | (3 | (4 | (3 | (3 | (4 | (3 | (3 | (4 |
| Xylene (o,m,p)----- | (4 | (3 | (3 | (4 | (3 | (3 | (4 | (3 | (3 | (4 | (3 | (3 | (4 |
| Dichlorobenzene (o,m,p)----- | (9 | (5 | (4 | (9 | (5 | (4 | (9 | (5 | (4 | (9 | (5 | (4 | (9 |
| Total----- | 24 | 165 | 188 | 818 | 35 | 22 | 8 | 0 | 0 | 0 | 591 | 518 | 5782 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

7-No Mention On Lab Results

R2-0000077

TABLE 9-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-8 | NC-8 | NC-8 | NC-9 | NC-9 | NC-9 | NC-10 | NC-10 | NC-10 | NC-11 | NC-11 | NC-11 | NC-12 |
|-----------------------------------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|---------|----------|---------|
| WELL DEPTH----- | 57 | 57 | 57 | 59 | 59 | 59 | 58 | 58 | 58 | 58 | 58 | 58 | 57 |
| SAMPLE DATE----- | 12/4/84 | 9/26/85 | 12/27/85 | 12/5/84 | 3/25/85 | 12/27/85 | 12/5/84 | 3/25/85 | 12/26/85 | 12/5/84 | 3/27/85 | 12/27/85 | 12/5/84 |
| Trichlorofluoromethane----- | (1 | (1 | NA | (1 | (1 | NA | (1 | (1 | NA | (1 | (1 | NA | (1 |
| Methylene Chloride-----) | | | | | | | | | | | | | |
| 1,1,2-Trichlorotrifluoroethane--) | 43 | (4 | (8 | (10 | 14 | 39 | (10 | (4 | (8 | 39 | 28 | 54 | (10 |
| 1,1-Dichloroethylene-----) | | | | | | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | 120 | | (14 | (15 | | (14 | (15 | | (14 | 17 | | (14 | (15 |
| t-1,2-Dichloroethylene----- | | (5 | | | (5 | | | (5 | | | (5 | | |
| 1,1-Dichloroethane----- | (15 | NA | (14 | (15 | NA | 35 | (15 | NA | (14 | NR | NA | (14 | (15 |
| c-1,2-Dichloroethylene----- | | (20 | | | (20 | | (20 | | (20 | | (20 | | |
| Chloroform----- | 9 | 1 | (1 | 13 | 250 | 110 | (1 | (1 | (1 | 8 | 6 | 9 | (1 |
| 1,1,1-Trichloroethane----- | 42 | 13 | 31 | 50 | 150 | 180 | 1 | 1 | 1 | 35 | 26 | 20 | 3 |
| Carbon Tetrachloride----- | (1 | (1 | (1 | 1 | 12 | 1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 |
| Trichloroethylene----- | 68 | 12 | 10 | 24 | 39 | 100 | (1 | (1 | (1 | 150 | 120 | 120 | 1 |
| Bromodichloroethane----- | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | (2 | | | (2 | | | (2 | | | (2 | | | (2 |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | | (1 | (1 | | (1 | (1 | | (1 | (1 | | (1 | (1 | |
| 1,1,2-Trichloroethane-----) | | (2 | (1 | | (2 | (1 | | (2 | (1 | | (2 | (1 | |
| 1,2-Dibromoethane----- | (60 | NR | NA | (6 | (2 | NA | (6 | (2 | NA | (6 | (2 | NA | (6 |
| Tetrachloroethylene----- | 2300 | 920 | 440 | 46 | 72 | 62 | 1 | 1 | 1 | 32 | 20 | 14 | 1 |
| Bromoform----- | (3 | (1 | (2 | (3 | (1 | (2 | (3 | (1 | (2 | (3 | (1 | (2 | (3 |
| Benzene----- | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 |
| Toluene----- | (3 | (4 | (6 | (3 | (4 | (6 | (3 | (4 | (6 | (3 | (4 | (6 | (3 |
| Chlorobenzene----- | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 | (3 |
| Ethylbenzene----- | (3 | (3 | (6 | (3 | (3 | (6 | (3 | (3 | (6 | (3 | (3 | (6 | (3 |
| Xylene (o,m,p)----- | (3 | (3 | (6 | (3 | (3 | (6 | (3 | (3 | (6 | (3 | (3 | (6 | (3 |
| Dichlorobenzene (o,m,p)----- | (5 | (4 | (9 | (5 | (4 | (9 | (5 | (4 | (9 | (5 | (4 | (9 | (5 |
| Total----- | 2582 | 946 | 481 | 134 | 537 | 527 | 2 | 2 | 2 | 275 | 200 | 211 | 5 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

7-No Mention On Lab Results

TABLE 3-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| NUMBER----- | NC-12 | NC-12 | NC-13 | NC-13 | NC-14 | NC-14 | NC-15 | NC-15 | NC-16 | NC-16 | NC-17 | NC-17 | NC-18 |
|-------------------------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| DEPTH----- | 57 | 57 | 68 | 68 | 68 | 68 | 66 | 66 | 64 | 64 | 64 | 64 | 60 |
| DATE----- | 9/27/85 | 12/26/85 | 10/28/85 | 12/31/85 | 10/28/85 | 12/31/85 | 10/30/85 | 12/31/85 | 10/28/85 | 12/31/85 | 10/31/85 | 12/30/85 | 11/25/85 |
| chlorofluoroethane----- | <1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ylene Chloride-----) | | | | | | | | | | | | | |
| 2-Trichlorotrifluoroethane--) | <4 | <8 | NR | <8 | NR | <8 | NR | <8 | NR | <8 | NR | <8 | <6 |
| Dichloroethylene-----) | | | | | | | | | | | | | |
| t-1,2-Dichloroethylene----- | | <14 | <14 | <14 | <14 | <14 | <14 | <14 | <14 | <14 | <14 | <14 | NR |
| 2-Dichloroethylene----- | <3 | | | | | | | | | | | | |
| Dichloroethane----- | NA | <14 | <15 | <14 | <15 | <14 | <15 | <14 | <15 | <14 | <15 | <14 | NR |
| 2-Dichloroethylene----- | <20 | | | | | | | | | | | | |
| rofore----- | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1-Trichloroethane----- | 1 | 3 | 5 | 8 | <1 | <1 | 4 | 5 | <1 | <1 | 2 | 2 | 9 |
| on Tetrachloride----- | <1 | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | <1 |
| hloroethylene----- | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 2 | 7 | <1 | <1 | 11 |
| odichloroethane----- | <1 | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | <1 |
| 3-Dichloropropene-----) | | | | | | | | | | | | | |
| osochloroethane-----) | | | | | | | | | | | | | |
| 2-Trichloroethane-----) | | | | | | | | | | | | | |
| 3 Dichloropropene-----) | | | | | | | | | | | | | |
| osochloroethane-----) | <1 | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | NR | <1 | <1 |
| 2-Trichloroethane----- | <2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Dibromoethane----- | <2 | NA | <1 | NA | <1 | NA | <1 | NA | <1 | NA | <1 | NA | <1 |
| achloroethylene----- | 7 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 3 | 9 | <1 | <1 | 3 |
| ofore----- | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <2 |
| ene----- | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | NA |
| ene----- | <4 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | NA |
| robenzene----- | <3 | <3 | <4 | <3 | <4 | <3 | <4 | <3 | <4 | <3 | <4 | <3 | NA |
| lbenzene----- | <3 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | <4 | <6 | NA |
| ne (o,s,p)----- | <3 | <6 | NR | <6 | NR | <6 | NR | <6 | NR | <6 | NR | <6 | NA |
| lorobenzene (o,s,p)----- | <4 | <9 | <8 | <9 | <8 | <9 | <3 | <9 | <8 | <9 | <8 | <9 | NA |
| 1----- | 9 | 3 | 5 | 8 | 0 | 0 | 4 | 5 | 5 | 16 | 2 | 2 | 23 |

Not Analyzed

NR-No Result Due To Technical Reasons

?--No Mention On Lab Results

TABLE 3-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-18 | NC-19 | NC-19 | NC-20 | NC-20 | NC-21 | NC-21 | 9998 | 9998 | NC-22d | NC-22d | NC-29 | NC-29 |
|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|
| WELL DEPTH----- | 60 | 62 | 62 | 60 | 60 | 63 | 63 | 80 | 80 | 125 | 125 | 64 | 64 |
| SAMPLE DATE----- | 12/30/85 | 10/30/85 | 12/30/85 | 10/31/85 | 12/30/85 | 10/30/85 | 12/30/85 | 5/10/85 | 12/23/85 | 11/26/85 | 12/23/85 | 10/30/85 | 12/23/85 |
| Trichlorofluoroethane----- | NA | NA | NA | NA | NA | NA | NA | <1 | NA | NA | NA | NA | NA |
| Methylene Chloride-----) | | | | | | | | | | | | | |
| 1,1,2-Trichlorotrifluoroethane--) | <8 | NR | <8 | NR | <8 | <9 | 9 | 58 | 1500 | <6 | <8 | NR | 100 |
| 1,1-Dichloroethylene-----) | | | | | | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | <14 | <15 | <14 | <15 | <14 | <94 | 94 | 82 | 82 | NR | <14 | <15 | <14 |
| t-1,2-Dichloroethylene----- | | | | | | | | | | | | | |
| 1,1-Dichloroethane----- | <14 | <26 | <14 | <26 | <14 | 26 | <14 | 64 | 46 | NR | <14 | <26 | <14 |
| c-1,2-Dichloroethylene----- | | | | | | | | | | | | | |
| Chloroform----- | <1 | 110 | 93 | <1 | <1 | 11 | 10 | <1 | 1 | <1 | <1 | <1 | <1 |
| 1,1,1-Trichloroethane----- | 4 | 2 | 2 | 94 | 260 | 58 | 150 | 610 | 7700 | 6 | 8 | 11 | 14 |
| Carbon Tetrachloride----- | <1 | NR | <1 | NR | <1 | <1 | <1 | <10 | <1 | <1 | <1 | NR | <1 |
| Trichloroethylene----- | 2 | 2 | 9 | 36 | 11 | 86 | 310 | 360 | 460 | <1 | <1 | 9 | 13 |
| Bromodichloroethane----- | <1 | NR | <1 | NR | <1 | <1 | <1 | <10 | <1 | <1 | <1 | NR | <1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | | | | | | | | | | | | | |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| c-1,3 Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | <1 | NR | <1 | NR | <1 | <1 | <1 | <1 | <1 | <1 | <1 | NR | <1 |
| 1,1,2-Trichloroethane-----) | <1 | <1 | <1 | <1 | <1 | <3 | <1 | 2 | 2 | <1 | <1 | <1 | <1 |
| 1,2-Dibromoethane----- | NA | <1 | NA | <1 | NA | <1 | NA | <1 | NA | <1 | NA | <1 | NA |
| Tetrachloroethylene----- | 2 | 9 | 14 | 100 | 130 | 240 | 450 | 42 | 59 | <1 | 2 | <1 | <1 |
| Bromoform----- | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <1 | <2 | <2 | <2 | <1 | <2 |
| Benzene----- | <3 | <3 | <3 | <3 | <3 | 2 | <3 | <3 | <3 | NA | <3 | <3 | <3 |
| Toluene----- | <6 | <5 | <6 | <5 | <6 | <4 | <6 | <4 | <6 | NA | <6 | <5 | <6 |
| Chlorobenzene----- | <3 | <3 | <3 | <3 | <3 | <2 | <3 | <3 | <3 | NA | <3 | <3 | <3 |
| Ethylbenzene----- | <6 | <3 | <6 | 3 | <6 | <5 | <6 | <5 | <6 | NA | <6 | <3 | <6 |
| Xylene (o,m,p)----- | <6 | NR | <6 | 13 | <6 | 7 | <6 | <4 | <6 | NA | <6 | NR | <6 |
| Dichlorobenzene (o,m,p)----- | <9 | <8 | <9 | <8 | <9 | <11 | <9 | <8 | <9 | NA | <9 | <8 | <9 |
| Total----- | 8 | 123 | 112 | 246 | 401 | 430 | 1023 | 1168 | 9800 | 6 | 10 | 20 | 127 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

7-No Mention On Lab Results

TABLE 9-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-24 | NC-24 | NC-25 | NC-25 | NC-26a | NC-26a | NC-26d | NC-26d | NC-27 | NC-27 | NC-27 | NC-28a | NC-28a |
|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| WELL DEPTH----- | 65 | 65 | 60 | 60 | 62 | 62 | 120 | 120 | 60 | 60 | 60 | 57 | 57 |
| SAMPLE DATE----- | 10/30/85 | 12/29/85 | 10/31/85 | 12/24/85 | 10/28/85 | 12/26/85 | 10/29/85 | 12/26/85 | 10/31/85 | 11/25/85 | 12/26/85 | 10/31/85 | 12/31/85 |
| Trichlorofluoroethane----- | NA | NA | NA | NA | (NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylene Chloride-----) | | | | | | | | | | | | | |
| 1,1,2-Trichlorotrifluoroethane--) | NR | 28 | NR | 190 | (9 | (8 | NR | (8 | 220 | (8 | 95 | NR | (8 |
| 1,1-Dichloroethylene-----) | | | | | | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | 37 | 39 | 63 | 100 | (94 | (14 | (14 | (14 | 20 | NR | (14 | (14 | (14 |
| t-1,2-Dichloroethylene----- | | | | | | | | | | | | | |
| 1,1-Dichloroethane----- | 71 | 59 | 100 | 88 | (12 | (14 | (15 | (14 | (26 | NR | (14 | (15 | (14 |
| c-1,2-Dichloroethylene----- | | | | | | | | | | | | | |
| Chloroform----- | (1 | (1 | (1 | (1 | 8 | 1 | 1 | (1 | 8 | 2 | 3 | (1 | (1 |
| 1,1,1-Trichloroethane----- | 370 | 320 | 470 | 700 | 11 | 13 | 1 | 19 | 51 | 68 | 85 | (1 | (1 |
| Carbon Tetrachloride----- | NR | (1 | NR | (1 | (1 | (1 | NR | (1 | NR | (1 | (1 | NR | (1 |
| Trichloroethylene----- | 9 | 15 | 74 | 120 | (2 | (1 | (1 | 2 | 78 | 200 | 200 | (1 | (1 |
| Bromodichloroethane----- | NR | (1 | NR | (1 | (1 | (1 | NR | (1 | NR | (1 | (1 | NR | (1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | | | | | | | | | | | | | |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | | | |
| c-1,3 Dichloropropene-----) | | | | | | | | | | | | | |
| Dibromochloroethane-----) | NR | (1 | NR | (1 | (1 | (1 | NR | (1 | NR | (1 | (1 | NR | (1 |
| 1,1,2-Trichloroethane----- | (1 | (1 | 3 | 4 | (8 | (1 | (1 | (1 | (1 | (1 | (1 | (1 | (1 |
| 1,2-Dibromoethane----- | (1 | NA | NR | NA | (1 | NA | (1 | NA | (1 | NA | NA | (1 | NA |
| Tetrachloroethylene----- | 100 | 280 | 340 | 620 | (1 | (1 | (1 | 1 | 30 | 41 | 51 | (1 | (1 |
| Bromoform----- | (1 | (2 | (1 | (2 | (1 | (2 | (1 | (2 | (1 | (2 | (2 | (1 | (2 |
| Benzene----- | (3 | (3 | (3 | (3 | (2 | (3 | (3 | (3 | (3 | NA | 3 | (3 | (3 |
| Toluene----- | (3 | (6 | (5 | (6 | (4 | (6 | (4 | (6 | (5 | NA | (6 | (4 | (6 |
| Chlorobenzene----- | (3 | (3 | (3 | (3 | (2 | (3 | (4 | (3 | (3 | NA | (3 | (4 | (3 |
| Ethylbenzene----- | (3 | (6 | (3 | (6 | (5 | (6 | (4 | (6 | (3 | NA | (6 | (4 | (6 |
| Xylene (o,m,p)----- | NR | (6 | 8 | (6 | (6 | (6 | NR | (6 | NR | NA | NR | 7 | (6 |
| Dichlorobenzene (o,m,p)----- | (8 | (9 | (8 | (9 | (11 | (9 | (8 | (9 | (8 | NA | (9 | (8 | (9 |
| Total----- | 587 | 735 | 1058 | 1822 | 14 | 14 | 2 | 22 | 402 | 311 | 377 | 7 | 0 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

?-No Mention On Lab Results

TABLE 3-2

ANALYTICAL RESULTS - NEW CASSEL - GROUNDWATER QUALITY

| WELL NUMBER----- | NC-28s | NC-28d | NC-29s | NC-29s | NC-29s | NC-29d | NC-29d | NC-29s | NC-29s | NC-30d | NC-30d |
|-----------------------------------|--------|----------|---------|----------|---------|----------|---------|----------|----------|----------|---------|
| WELL DEPTH----- | 57 | 190 | 57 | 57 | 57 | 121 | 121 | 40 | 40 | 118 | 118 |
| SAMPLE DATE----- | 2/3/86 | 10/29/85 | 11/1/85 | 12/31/85 | 1/31/86 | 11/25/85 | 1/30/86 | 11/25/85 | 12/31/85 | 11/26/85 | 1/30/86 |
| Trichlorofluoroethane----- | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Methylene Chloride-----) | | | | | | | | | | | |
| 1,1,2-Trichlorotrifluoroethane--) | <7 | NR | NR | <8 | <7 | <6 | 12 | <6 | <8 | <6 | <7 |
| 1,1-Dichloroethylene-----) | | | | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | <10 | <14 | 72 | 94 | 120 | NR | <10 | NR | <14 | NR | <10 |
| t-1,2-Dichloroethylene----- | | | | | | | | | | | |
| 1,1-Dichloroethane----- | <12 | <15 | <26 | <14 | <12 | NR | <12 | NR | <14 | NR | <12 |
| c-1,2-Dichloroethylene----- | | | | | | | | | | | |
| Chloroform----- | <1 | <1 | <1 | <1 | <1 | <1 | 1 | <1 | 2 | 1 | 2 |
| 1,1,1-Trichloroethane----- | <1 | 2 | <1 | <1 | <1 | 19 | 21 | 2 | 8 | 15 | 19 |
| Carbon Tetrachloride----- | <1 | NR | NR | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Trichloroethylene----- | <1 | <1 | 24 | 16 | 16 | 4 | 8 | <1 | <1 | 1 | 2 |
| Bromodichloroethane----- | <1 | NR | NR | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| c-1,3-Dichloropropene-----) | | | | | | | | | | | |
| Dibromochloroethane-----) | | | | | | | | | | | |
| 1,1,2-Trichloroethane-----) | | | | | | | | | | | |
| c-1,3 Dichloropropene-----) | | | | | | | | | | | |
| Dibromochloroethane-----) | <1 | NR | NR | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,1,2-Trichloroethane----- | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,2-Dibromoethane----- | NA | <1 | NR | NA | NA | <1 | NA | <1 | NA | <1 | NA |
| Tetrachloroethylene----- | <1 | <1 | 640 | 560 | 940 | 4 | 6 | <1 | <1 | 8 | 4 |
| Bromoform----- | <1 | <1 | <1 | NR | <1 | <2 | <1 | <2 | <2 | <2 | <1 |
| Benzene----- | <3 | <3 | <3 | <3 | <3 | NA | <3 | NA | <3 | NA | <3 |
| Toluene----- | <4 | 5 | <5 | <6 | <4 | NA | <4 | NA | <6 | NA | <4 |
| Chlorobenzene----- | <4 | <4 | <3 | <3 | <4 | NA | <4 | NA | <3 | NA | <4 |
| Ethylbenzene----- | <4 | <4 | <3 | <6 | <4 | NA | <4 | NA | <6 | NA | <4 |
| Xylene (o,m,p)----- | <5 | NR | <3 | <6 | <5 | NA | <5 | NA | <6 | NA | <5 |
| Dichlorobenzene (o,m,p)----- | <9 | <8 | <8 | <9 | <9 | NA | <9 | NA | <9 | NA | <9 |
| Total----- | 0 | 7 | 736 | 670 | 1076 | 27 | 48 | 2 | 10 | 20 | 27 |

NA-Not Analyzed

NR-No Result Due To Technical Reasons

7-No Mention On Lab Results

ANALYTICAL RESULTS
NEW CASSEL - GROUNDWATER QUALITY

| Well Number----- | N5655 | N6819 | N6848 | N7732 | N8472 | N8497 | N8956 | N8957 |
|-----------------------------------|--------|--------|---------|---------|---------|---------|---------|--------|
| Well Depth (feet)*----- | 260 | 260 | 104 | 108 | 195 | 544 | 530 | 584 |
| Sample Date----- | 8/7/85 | 8/7/85 | 5/10/85 | 5/10/85 | 5/10/85 | 8/21/85 | 4/11/85 | 2/6/85 |
| Trichlorofluoromethane----- | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Methylene Chloride-----) | NA | NA | 6 | 230 | < 4 | NA | < 4 | < 10 |
| 1,1,2-Trichlorotrifluoroethane--) | | | | | | | | |
| 1,1-Dichloroethylene-----) | | | | | | | | |
| c & t-1,2-Dichloroethylene----- | NA | NA | <25 | 48 | <25 | NA | <20 | NA |
| t-1,2-Dichloroethylene----- | < 1 | < 1 | NA | NA | NA | < 1 | NA | < 7 |
| 1,1-Dichloroethane----- | < 1 | < 1 | 74 | 860 | NA | < 1 | NA | NA |
| c-1,2-Dichloroethylene----- | < 1 | < 1 | NA | NA | NA | < 1 | NA | NA |
| Chloroform----- | < 1 | < 1 | < 1 | 2 | < 1 | < 1 | < 1 | < 1 |
| 1,1,1-Trichloroethane----- | < 1 | < 1 | 35 | 1200 | 10 | < 1 | < 1 | < 1 |
| Carbon Tetrachloride----- | < 1 | < 1 | < 1 | < 10 | 1 | < 1 | < 1 | < 1 |
| Trichloroethylene----- | < 1 | < 1 | 1 | 360 | 6 | < 1 | < 1 | < 1 |
| Bromodichloromethane----- | < 1 | < 1 | < 1 | < 10 | < 1 | < 1 | < 1 | < 1 |
| c-1,3-Dichloropropene-----) | | | | | | | | |
| Dibromochloromethane-----) | NA | NA | NA | NA | NA | NA | | |
| 1,1,2-Trichloroethane-----) | | | | | | | | |
| c-1,3-Dichloropropene-----) | NA | NA | < 1 | < 1 | < 1 | NA | < 1 | < 1 |
| Dibromochloromethane-----) | < 1 | < 1 | < 1 | 5 | < 1 | < 1 | < 2 | < 3 |
| 1,1,2-Trichloroethane----- | | | | | | | | |
| 1,2-Dibromoethane----- | NA | NA | < 1 | < 1 | < 1 | NA | < 2 | < 2 |
| Tetrachloroethylene----- | 4 | < 1 | 1 | 21 | 4 | < 1 | < 1 | < 2 |
| Bromoform----- | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Benzene----- | NA | NA | < 3 | < 3 | < 3 | NA | < 3 | < 5 |
| Toluene----- | NA | NA | < 4 | < 4 | < 4 | NA | < 4 | < 3 |
| Chlorobenzene----- | < 1 | < 1 | < 4 | < 4 | < 4 | < 1 | < 3 | < 3 |
| Ethylbenzene----- | NA | NA | < 5 | < 5 | < 3 | NA | < 3 | < 3 |
| Xylene (o,m,p)----- | NA | NA | < 4 | < 4 | < 4 | NA | < 3 | < 3 |
| Dichlorobenzene (o,m,p)----- | NA | NA | < 8 | < 8 | < 8 | NA | < 4 | < 10 |
| Total----- | 4 | 0 | 117 | 2,726 | 21 | 0 | 0 | 0 |

*Below Ground Surface
NA - Not Analyzed

TABLE 3-3

NEW CASSEL - CONTAMINATED AQUIFER SEGMENTS
 TOTAL ORGANIC COMPOUNDS
 DATA SUMMARY
 (ug/l)

| <u>New Cassel</u> | <u>Depth*</u> <u>(Feet)</u> | <u>Mean</u> | <u>Range</u> | <u>Median</u> | <u>Number of</u> <u>Data Points</u> |
|-------------------|--------------------------------|-------------|--------------|---------------|--|
| NC-1 | 60 | 2 | 1-3 | | 2 |
| NC-2s | 57 | 2927 | 2554-3557 | 2798 | 4 |
| NC-2d | 120 | 797 | | | 1 |
| NC-3 | 60 | 35 | 24-45 | | 2 |
| NC-4 | 62 | 503 | 188-818 | | 2 |
| NC-5 | 67 | 15 | 8-22 | | 2 |
| NC-6 | 62 | 0 | 0-0 | | 2 |
| NC-7 | 57 | 3150 | 518-5782 | | 2 |
| NC-8 | 57 | 714 | 481-946 | | 2 |
| NC-9 | 59 | 532 | 527-537 | | 2 |
| NC-10 | 58 | 2 | 2-2 | | 2 |
| NC-11 | 58 | 206 | 200-211 | | 2 |
| NC-12 | 57 | 6 | 3-9 | | 2 |
| NC-13 | 68 | 8 | | | 1 |
| NC-14** | 68 | 0 | | | 1 |
| NC-15 | 66 | 5 | | | 1 |
| NC-16 | 64 | 16 | | | 1 |
| NC-17 | 64 | 2 | | | 1 |
| NC-18† | 60 | 8 | | | 1 |
| NC-19 | 62 | 112 | | | 1 |
| NC-20 | 60 | 401 | | | 1 |
| NC-21 | 63 | 1023 | | | 1 |
| NC-22d | 125 | 10 | | | 1 |
| NC-23 | 64 | 127 | | | 1 |
| NC-24 | 65 | 735 | | | 1 |
| NC-25† | 60 | 1822 | | | 1 |
| NC-26s | 62 | 14 | | | 1 |
| NC-26d | 120 | 22 | | | 1 |
| NC-27 | 60 | 344 | 311-377 | | 2 |
| NC-28s | 57 | 0 | 0-0 | | 2 |
| NC-28d | 130 | (7) | | | (1) |
| NC-29s | 57 | 873 | 670-1076 | | 2 |
| NC-29d | 121 | 48 | | | 1 |
| NC-30s | 40 | 10 | | | 1 |
| NC-30d | 118 | 27 | | | 1 |
| N5655 | 260 | 4 | | | 1 |
| N6819 | 260 | 0 | | | 1 |
| N6848 | 104 | 117 | | | 1 |
| N7732 | 108 | 2726 | | | 1 |

TABLE 3-3 (continued)

NEW CASSEL - CONTAMINATED AQUIFER SEGMENTS
TOTAL ORGANIC COMPOUNDS
DATA SUMMARY
(ug/l)

| <u>New Cassel</u> | <u>Depth*</u> <u>(Feet)</u> | <u>Mean</u> | <u>Range</u> | <u>Median</u> | <u>Number of</u> <u>Data Points</u> |
|-------------------|--------------------------------|-------------|--------------|---------------|--|
| N8472 | 195 | 21 | | | 1 |
| N8497 | 544 | 0 | | | 1 |
| N8956 | 530 | 0 | | | 1 |
| N8957 | 584 | 0 | | | 1 |
| N9938 | 80 | 9800 | | | 1 |

Note: The first sample after well development was discarded in this data summary when more than one well analyses exist

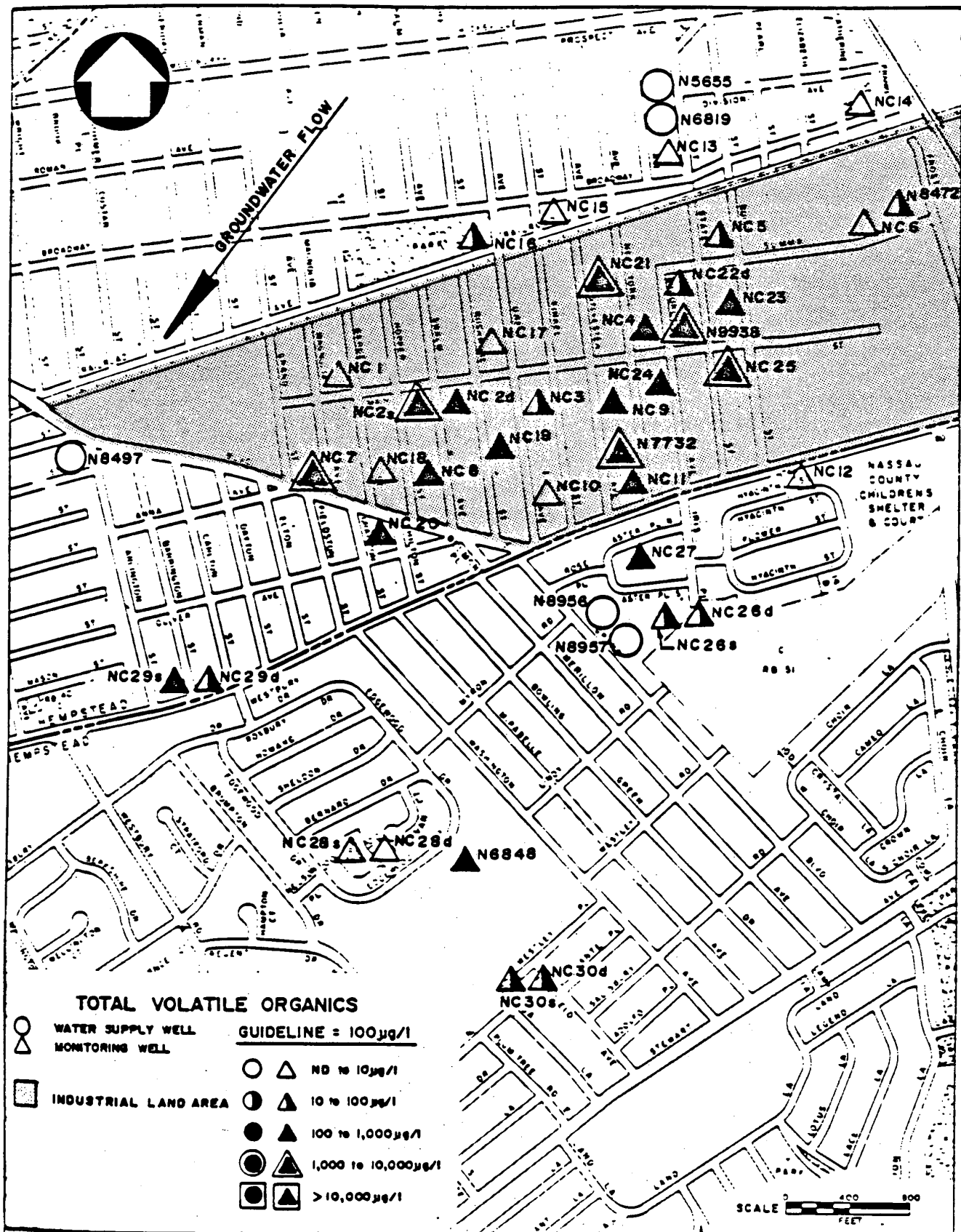
* Below ground surface

**No information is available on soil or drill cutting backfill

† Soil sample of drill cutting backfill indicate the following parameters:

NC-18 Ethylbenzene 140 ppb
Xylene 160 ppb
NC-25 1,1,1-trichloroethane 26 ppb

() This is the first sample after well development; no subsequent samples available for this well.



wells, NC-28s is not contaminated at shallower depths, however, the one sample available for NC-28d has 7 ug/l reported for total organic compounds. Wells with 1 to 10 ug/l detected for total organic compounds are:

| <u>Well Number</u> | <u>Total Organic Compounds (ug/l)</u> |
|--------------------|---|
| NC-1 | 2 |
| NC-10 | 2 |
| NC-12 | 6 |
| NC-13 | 8 |
| NC-15 | 5 |
| NC-17 | 2 |
| NC-18 | 8 |
| NC-22d | 10 |
| N-5655 | 4 |

Seven of these wells are about 60 feet deep, but NC-22d (125 feet) and N5655 (270 feet) are deeper.

The data suggests that the glacial and upper Magothy aquifers up to 120 feet below the surface are significantly contaminated with organic compounds. Some contamination also exists in wells up to 240 feet deep. Wells greater than 500 feet deep are not contaminated in the New Cassel area. The suite of organic compounds that are found in the shallow wells are larger than, but similar to compounds detected at greater depths. The site specific hydrogeology needs additional investigation before prediction of contaminant movement can be assessed.

Upgradient wells, such as NC-14, N-6, NC-13 and N-15 indicate that the source of organic contamination in New Cassel is to the south of these wells and in an industrial area.

For the six most contaminated wells, the following analysis is provided based on specific chemicals detected. Levels of total organic compounds for NC-7, the well furthest downgradient within the industrial area, increased from 518 ug/l in February 1985 to 5,782 ug/l in December 1985. (The first analysis in December 1984 reported 591 ug/l of total organic compounds was discarded as described in Section 3.1.) This increase can be attributed to two chemicals; 1,1-dichloroethane was not analyzed for in the February sample and had a reported concentration of 1,300 ug/l in December 1985; 1,1,1-trichloroethane increased from 510 ug/l to 4,400 ug/l. Further sampling and analyses for NC-7 are necessary to determine a consistent value and/or quantify any increasing trends.

There are several industrial users of 1,1,1-trichloroethane upgradient of well NC-7, but reported annual usage is generally small, less than 35 gallons per year. 1,1,1-trichloroethane may also have been used as a cesspool cleaning product prior to recent sewerage of the area. There is no reported industrial use of 1,1-dichloroethane in the New Cassel area; however, this compound is a degradation product of 1,1,1-trichloroethane.

Well NC-2s, about 800 feet upgradient from NC-7 has four analyses available from December 1984 to December 1985 (a fifth

was discarded as described in Section 3.1). Total organics increased from 2,554 to 3,557 ug/l over the year. This increase results primarily from two chemicals; 1,1,1-trichloroethane increased from 40 ug/l to 390 ug/l and trichloroethylene increased from 1,300 ug/l in the first sample to about 2,200 ug/l in the three subsequent analyses. Bromoform decreased from 1,200 ug/l in December 1984 to 450 ug/l in two samples taken March 1984. The most recent analysis for bromoform in this well was 950 ug/l. Currently, there are no reported industrial users of bromoform in the area. Bromoform is used in pharmaceutical manufacturing, as an ingredient in fire resistant chemicals and gauge fluid, and as a solvent for waxes, grease and oils.

1,1,1-trichloroethane has apparently migrated deeper into well NC-2d at a reported concentration of 430 ug/l in the one sample taken from this well. Well NC-21, about 1,200 feet upgradient of NC-2 shows a slightly different suite of contaminants; 1,1,1-trichloroethane is still present, but at a lower concentration (150 ug/l). Trichloroethylene (350 ug/l) and tetrachloroethylene (450 ug/l) are the largest contaminants in this well. There are several large users of trichloroethylene (300-1,000 gallons/year) and tetrachloroethylene in the New Cassel area (see Table 3-1).

Well N7732, located about 1,200 feet to the east of NC-2, has several contaminants reported in the most recent routine analysis; 1,1-dichloroethane (860 ug/l) and 1,1,1-trichloroethane (1,200 ug/l) are found in amounts that are similar to NC-7 and NC-2. Trichloroethylene is reported at 360 ug/l, but tetrachloroethylene is reported at only 21 ug/l. The other major constituent reported is methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene (not resolved analytically). There are several industries in the New Cassel area that report using methylene chloride up to 8,000 gallons per year.

NC-25 (one analysis used), located about 800 feet upgradient from N7732 and about 800 feet southwest of NC-21 contains 1,1,1-trichloroethane (700 ug/l), trichloroethylene (620 ug/l), methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene (100 ug/l) and trichloroethylene (120 ug/l).

Well N9938 (one analysis used), located 400 feet to the northwest of NC-25 has 7,700 ug/l of 1,1,1-trichloroethane, 1,500 ug/l of methylene chloride/1,1,2-trichlorotrifluoroethane/1,1-dichloroethylene and 460 ug/l of trichloroethylene.

In summary, it appears that contamination has migrated in the glacial and upper Magothy aquifer downgradient of the New Cassel area. Public water supply wells located as close as 800 feet from significantly contaminated observation wells, however,

do not show signs of contamination. This indicates that the deeper portions of the Magothy aquifer in the study area have not been affected at the present time. However, lack of well defined clay layers as described in Section 3.2.2 indicates that there is a potential threat to water supply wells in and downgradient of this area.

3.3 Garden City Park

3.3.1 Site Description

As shown in Figure 3-6, Garden City Park is a one square mile area that is part of the Town of North Hempstead. The northern border is along Hillside Avenue and extends southwards to the railroad tracks south of Jericho Turnpike. The eastern border is Herricks Road adjacent to Mineola, and the western boundary is approximately located by Leonard Boulevard next to New Hyde Park. All of the wells in this study are located in the most southern part of Garden City Park between the Long Island Railroad and Jericho Turnpike on the north (Figure 3-7). Two wells are located across the southern border into Garden City Village.

The major land uses are residential, commercial and industrial. The residential area, mainly to the north, is medium density, with five to ten dwelling units per acre. Commercial activity is concentrated in elongated strips along Jericho

Turnpike. Industry is concentrated along the southern railroad border of Garden City Park and in a north-south strip along Denton Avenue.

The area is serviced by the Town of North Hempstead Garden City Park Water District, and is part of Nassau County Sewage Disposal District #2 which has been serving the area since the early 1950's. The area was developed approximately 40 years ago and there is little current growth. The 1980 population was 7,712 people, an increase of 300 people since 1970. There are two former landfills in Garden City Park along Denton Avenue. These landfills are discussed in Section 3.5 because they are closer to wells drilled as part of the New Hyde Park groundwater investigation.

There are no known historical occurrences of groundwater contamination in this area. However, past storage and disposal practices of industry in the area are potential sources of contamination. In the 1977-1978 Industrial Survey Report prepared by NCDH, methods of disposing of organic chemical waste in this area included discharging of chemicals into drains and drywells, and disposal into trash or at unidentified landfills. Follow-up action required the cessation of these activities, but the impact on groundwater quality as a result of previous activities is unknown.

4.0 Contaminated Aquifer Management and Remedial Alternatives

Based on the preliminary contamination assessment of the five areas, there are several applicable management alternatives. The most immediate management alternative to mitigate groundwater contamination is to abate the sources of contamination. This often requires a comprehensive investigation comprising surveys, soil borings, monitoring well installation, and sampling and analysis of waste discharges, soils, sediments and groundwater to identify the contaminant source. However, if the site problem involves more than source abatement, which is the situation for most of the five areas in this study, and soil and groundwater are significantly contaminated, the approach to remedial action is more complex.

Depending on the site specific problem, a number of remedial alternatives are available. Once the source(s) have been determined, abatement alternatives include discharge elimination (hold and haul); treatment prior to groundwater discharge; and discharge to a municipal treatment facility with or without pretreatment depending on the quantity and level of contamination. This is done as part of the New York State Pollutant Discharge Elimination System and Nassau County Public Health Ordinance, Articles Nine and Eleven. In order to determine the most implementable and cost-effective solution it is important to first define the site problem.

Site problems can generally be placed in one or more of the following categories: (1) air pollution; (2) surface water infiltration or contamination; (3) leachate generation and contaminated groundwater; (4) gas migration; (5) presence of wastes in drums, lagoons, tanks, etc; (6) contaminated sediments and soils; (7) contaminated water supply; and (8) contaminated sanitary and storm sewer lines.

With regard to the sites evaluated in this investigation, contaminated soils, groundwater and water supply are of most concern, although wastes themselves, organic vapor migration and contaminated sediments in storm drainage systems are also potential problems. Air contamination and surface water contamination are remote possibilities.

General response actions to mitigate these problems and associated remedial technologies are provided in Table 4-1. For the categories identified as of primary concern in this groundwater investigation above, Table 4-2 presents a list of remedial technologies classified according to the type of offsite problem (leachate generation and contaminated groundwater; contaminated sediments and soils; and contaminated water supply) they are intended to mitigate.

In order to determine the most appropriate remedial alternative or combination of alternatives, a cost-benefit analysis

TABLE 4-1

GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

| General Response Action | Technologies |
|--------------------------|---|
| No Action | Some monitoring and analyses may be performed. |
| Containment | Capping; groundwater containment barrier walls; bulkheads; gas barriers. |
| Pumping | Groundwater pumping; liquid removal; dredging. |
| Collection | Sedimentation basins; French drains; gas vents; gas collection systems. |
| Diversion | Grading; dikes and berms; stream diversion ditches; trenches; terraces and benches; chutes and downpipes; levees; seepage basins. |
| Complete Removal | Tanks; drums; soils; sediments; liquid wastes; contaminated structures; sewers and water pipes. |
| Partial Removal | Tanks; drums; soils; sediments; liquid wastes. |
| On-site Treatment | Incineration; solidification; land treatment; biological, chemical, and physical treatment. |
| Off-site Treatment | Incineration; biological, chemical, and physical treatment. |
| In Situ Treatment | Permeable treatment beds; bioreclamation; soil flushing; neutralization; land farming. |
| Storage | Temporary storage structures. |
| On-site Disposal | Landfills; land application. |
| Off-site Disposal | Landfills; surface impoundment; land application. |
| Alternative Water Supply | Cisterns; above ground tanks; deeper or upgradient wells; municipal water system; relocation of intake structure; individual treatment devices. |
| Relocation | Relocate residents temporarily or permanently. |

Source: U.S. Environmental Protection Agency

TABLE 4-2

ALTERNATIVE REMEDIAL TECHNOLOGIES TO
ADDRESS IDENTIFIED SITE PROBLEMS

Leachate and Groundwater Controls

o Capping

- Synthetic membranes
- Clay
- Asphalt
- Multimedia cap
- Concrete
- Chemical sealants/stabilizers

o Containment barriers

Function options

- Downgradient placement
- Upgradient placement
- Circumferential placement

Material and construction options
(vertical barriers)

- Soil-bentonite slurry wall
- Cement-bentonite slurry wall
- Vibrating beam
- Grout curtains
- Steel sheet piling

Horizontal barriers (bottom sealing)

- Block displacement
- Grout injection

o Groundwater pumping (generally used with
capping and treatment)

- Extraction and injection
- Extraction alone
- Injection alone

Equipment and Material Options

- Well points
- Deep wells

TABLE 4-2
(continued)

ALTERNATIVE REMEDIAL TECHNOLOGIES TO
ADDRESS IDENTIFIED SITE PROBLEMS

- Suction wells
- Ejector wells

o Subsurface Collection Drains

- French drains
- Tile drains
- Pipe drains (dual media drains)

Excavation and Removal of Waste and Soil

o Excavation and removal

- Backhoe
- Cranes and attachments
- Front end loaders
- Scrapers
- Pumps
- Industrial vacuums

o Grading

- Scarification
- Tracking
- Contour furrowing

o Capping (see Leachate and Groundwater Controls)

o Revegetation

- Grasses
- Legumes
- Shrubs
- Trees, conifers
- Trees, hardwoods

In Situ Treatment

- o Hydrolysis
- o Oxidation
- o Reduction
- o Soil aeration
- o Solvent flushing

TABLE 4-2
(continued)

ALTERNATIVE REMEDIAL TECHNOLOGIES TO
ADDRESS IDENTIFIED SITE PROBLEMS

- o Neutralization
- o Polymerization
- o Sulfide precipitation
- o Bioreclamation
- o Permeable treatment beds
- o Chemical dechlorination

- o Treatment of aqueous waste streams

Biological treatment

- Activated sludge
- Trickling filters
- Aerated lagoons
- Waste stabilization ponds
- Rotating biological disks
- Fluidized bed bioreactors

Chemical treatment

- Neutralization
- Precipitation
- Oxidation
- Hydrolysis
- Reduciton
- Chemical dechlorination
- Ultraviolet/ozonation

Physcial treatment

- Flow equalization
- Flocculation
- Sedimentation
- Activated carbon
- Kleensorb
- Ion exchange
- Reverse osmosis
- Liquid-liquid extraction
- Oil-water separator
- Steam distillation
- Air stripping
- Steam stripping
- Filtration
- Dissolved air flotation

TABLE 4-2
(continued)

ALTERNATIVE REMEDIAL TECHNOLOGIES TO
ADDRESS IDENTIFIED SITE PROBLEMS

Contaminated Water Supplies

- o Alternative drinking water supplies
- o Municipal water supply treatment (see Treatment
of aqueous waste streams - Physical Treatment)

Source: U.S. Environmental Protection Agency

needs to be undertaken. As part of this analysis, site characteristics, such as geology and hydrology; existing land use; proximity to water supply wells; and depth to groundwater, also needs to be evaluated. Because this report provides only a preliminary assessment of each of the study areas, additional data is required, especially to define the site specific hydrogeological characteristics. Much of the data gathered for this investigation can be directly applied to selection of remedial alternatives, however, location of sources and a more comprehensive and consistent assessment of water quality is needed at each site. Table 4-3 identifies site characteristics typically used in the alternative screening process.

In addition to site features, waste, contaminated soil and groundwater characteristics that limit the effectiveness or feasibility of remedial technologies need to be considered. These include physical properties of the contaminant, such as volatility, solubility and density; specific chemical constituents such as chlorinated organic chemicals or metals; and properties that determine the contaminant's degree of hazard, including persistence and toxicity. Waste characteristics which may influence the selection of the most appropriate remedial measure(s) are provided in Table 4-4.

The data obtained as part of this investigation does not provide sufficient information to recommend specific mitigation measures. The scope and detail of work required for this determination is substantially greater as compared to this study and is usually obtained in a formal Remedial Investigation and Feasibility Study (RI/FS). Typically, the cost for a RI/FS for each specific site is approximately \$750,000. As described in Section 1 (Introduction), the primary purpose of this project was limited to the identification of contaminated aquifer segments in Nassau County, and a preliminary assessment of the extent of groundwater contamination and areas of potential sources.

Although the scope of work is limited in this study, a preliminary selection of the most plausible remedial alternatives can be undertaken. Based on an assessment of site problems and features, and characteristics of the groundwater contaminants detected, the following mitigation measures have the greatest potential:

1. Source abatement and continued surveillance to monitor groundwater contamination (dependent upon threat to public water supply).
2. Capping, excavation and removal, and onsite flushing and treatment of contaminated soils (dependent upon extent, characteristics and location).

TABLE 4-3

SITE CHARACTERISTICS THAT MAY
AFFECT REMEDIAL TECHNOLOGY SELECTION

| | |
|-------------------------------|--------------------------|
| Site volume | Depth of bedrock |
| Site area | Depth to aquicludes |
| Site configuration | Degree of contamination |
| Disposal methods | Direction and rate of |
| Climate (precipitation, | groundwater flow |
| temperature, evaporation) | Receptors |
| Soil texture and permeability | Drinking water wells |
| Soil moisture | Surface waters |
| Slope | Ecological areas |
| Drainage | Existing land use |
| Vegetation | Depths of groundwater or |
| | plume |

TABLE 4-4

WASTE CHARACTERISTICS THAT MAY AFFECT
REMEDIAL TECHNOLOGY SELECTION

| | |
|------------------------|--------------------------|
| Quantity/concentration | Infectiousness |
| Chemical composition | Solubility |
| Acute toxicity | Volatility |
| Persistence | Density |
| Biodegradability | Partition coefficient |
| Radioactivity | Compatibility with other |
| Ignitability | chemicals |
| Reactivity/corrosivity | Treatability |

Source: U.S. Environmental Protection Agency

3. Vertical contaminant barriers (slurry wall, vibrating beam, etc.), and recovery wells with treatment, and recharge or discharge with pretreatment to a municipal treatment facility (dependent upon extent, characteristics, location and proximity to public water supply wells).
4. Relocation of water supply wells, and water supply treatment (dependent upon contaminant characteristics).

5.0 RECOMMENDATIONS

- o The findings of this report should be referred to the New York State Department of Environmental Conservation for State and USEPA Superfund consideration.
- o Continued investigations should be conducted in New Cassel, Garden City Park, West Hicksville and, to a lesser extent, North Hicksville and New Hyde Park to: complete definition of the horizontal and vertical extent of contamination; assess the threat to public water supply; identify contaminant sources; and motivate efforts to remediate contaminant sources and groundwater contamination. Further investigation should include: installation of additional wells; determination of the cause of anomalous water level readings in New Cassel and West Hicksville; collection of additional water quality and level data at existing wells to establish the consistency of data and identification of trends; and performance of additional detailed surveys of the industrial areas in the study areas.
- o On the basis of the extensive area and high level of contamination identified in New Cassel and the consequent threat to public water supply sources, consideration should be given to singling this area out for priority consideration as a site for Superfund type investigation and remediation.

- o Detailed industrial facility surveys should be performed in areas contiguous to and upgradient of wells which showed significant groundwater contamination.
- o Contaminated aquifer segments as found in Lake Success and Glen Cove, which are not being actively evaluated or remediated, should also be investigated.
- o Industrial areas of the County located within the Magothy recharge area (Hydrogeologic Zone I) that are not presently monitored for groundwater contamination should be investigated.

APPENDIX A

NC-1

0-1 sand, gravel fill.
1-20 light brown med.-coarse sand, med. gravel.
20-60 fine-med. clean tan sand.

NC-2s

0-2 fill
2-42 tan med.-coarse sand, med. gravel.
42-57 tan fine sand, fine gravel, interstitial clay.

NC-2d

0-2 black fill, sand.
2-6 gray silty sand.
6-23 coarse gravel, brown silty sand.
23-30 fine med. sand with binder.
30-53 coarse gravel, med. fine yellow sand.
53-119 med. fine sand.
119- fine sand, trace binder yellow.
135

NC-3

0-3 brown loam and gravel.
3-43 brown med.-coarse sand and gravel.
43-60 light brown med.-fine sand, fine gravel, trace silt,
interstitial clay.

NC-4

0-3 loam
3-40 brown med.-coarse sand with gravel.
40-62 tan fine sand with silt and interstitial clay.

NC-5

0-2 sand gravel fill.
2-45 brown med.-coarse sand, gravel, cobbles.
45-67 tan fine-med. sand, fine gravel, interstitial clay, silt.

NC-6

0-1 sand gravel fill.
1-44 brown med.-coarse sand and gravel.
44-62 tan fine-med. sand, trace fine gravel, silt.

NC-7

0-2 fill
2-35 brown med.-coarse sand and gravel.
35-57 med.-fine clean tan sand, trace gravel.

NC-8

0-2
2-42
42-57

sand, gravel fill.
brown med.-coarse sand and gravel.
fine-med. clean tan sand, trace fine gravel.

NC-9

0-2
2-40
40-59

sand gravel fill.
med.-coarse sand and gravel.
fine tan sand, silt, interstitial clay.

NC-10

0-1
1-38
38-58

sand gravel fill.
tan med.-coarse sand and gravel.
fine tan sand, trace fine gravel, silt, clay.

NC-11

0-3
3-40
40-60

loam fill.
light brown sand, trace med. gravel, clay, silt.
tan fine sand, interstitial clay.

NC-12

0-2
2-45
45-57

loam fill
brown sand, fine-med. gravel.
fine-med. sand, interstitial silt and clay.

NC-13

0-1
1-4
4-35

Topsoil.
fine brown silty sand.
med.-coarse light brown sand.
fine-coarse gravel, some cobbles.
fine white-brown sand, fine gravel.
fine yellowish-brown sand.
fine red-brown sand.
grayish white clay.

NC-14

0-2
2-20
20-45
45-55
55-70

Topsoil.
med.-coarse brown sand and gravel, some cobbles.
med.-coarse dark brown sand and gravel.
clean fine brown sand, trace of silt.
fine yellowish brown sand, trace of silt.

NC-16

0-2
2-16
16-40
40-50
55-66

Topsoil
med.-coarse sand and gravel, some cobbles.
med.-coarse dark brown sand and gravel.
clean fine brown sand, trace silt, seam of gray-white clay.
fine yellowish brown sand, trace silt.

NC-17

0-2 Topsoil
2-20 med.-coarse brown sand and gravel, some cobbles.
20-40 med.-coarse dark brown sand & gravel.
40-50 clean fine brown sand, trace silt.
50-66 fine yellowish brown sand, trace silt.

NC-19

0-2 Topsoil
2-20 med.-coarse brown sand & gravel, some cobbles, trace silt.
20-40 med.-coarse dark brown sand & gravel.
40-50 clean fine-med. brown sand & gravel.
50-64 fine-med. red brown sand, trace silt.

NC-21

0-2 Topsoil
2-16 med.-coarse sand & gravel, some cobbles.
16-40 med.-coarse dark brown sand & gravel.
40-50 clean fine brown sand, trace silt.
50-65 fine yellow brown sand, trace silt.

NC-22d

0-1 Topsoil
1-8 fine silty sand & gravel.
8-40 coarse gravel, fine-med. sand-brown.
40-49 coarse gravel, fine sand-yellow.
49-71 fine gravel, med. fine sand with binder.
71-125 fine gravel, med. fine sand.
125-140 med. fine sand.

NC-23

0-2 Topsoil
2-18 med.-coarse brown sand & gravel (some silt) some cobbles.
18-35 med.-coarse dark brown sand & gravel.
35-50 clean fine-med. light brown sand.
50-66 fine-med. red brown sand, trace silt.

NC-24

0-2 Topsoil
2-20 med.-coarse brown sand & gravel, some cobbles.
20-40 med.-coarse brown sand & gravel.
40-50 clean fine-med. brown sand, trace silt.
50-67 fine-med. yellowish brown sand, trace silt.

NC-26s

0-2 Topsoil
2-20 med.-coarse sand & gravel, some cobbles.
20-45 med.-coarse dark brown sand & gravel.
45-50 clean med. sand, slight brown.
50-65 fine-med. red brown sand, trace silt.

NC-26d

Through asphalt

| | |
|---------|--|
| 0-5 | fine brown silty sand. |
| 5-10 | med. coarse brown silty sand & gravel. |
| 10-16 | med. coarse sand & gravel. |
| 16-30 | med. coarse dark brown sand & gravel. |
| 30-60 | med. coarse red sandy silt. |
| 60-90 | fine white brown sandy silt & clay. |
| 90-100 | fine white brown sand. |
| 100-120 | fine red brown sandy silt & clay. |
| 120-132 | fine-med. light brown sand. |

NC-27

| | |
|-------|--|
| 0-2 | Topsoil |
| 2-20 | med.-coarse sand & gravel, some cobbles. |
| 20-45 | med.-coarse dark brown sand & gravel. |
| 45-50 | clean med. sand light brown. |
| 50-64 | fine-med. red brown sand, trace silt. |

NC-28s

| | |
|-------|---|
| 0-2 | Topsoil |
| 2-20 | med.-coarse brown sand & gravel, some cobbles. |
| 20-35 | med.-coarse dark brown sand & gravel. |
| 35-50 | clean fine red light brown sand, trace of silt. |
| 50-60 | dark gray silty clay, lenses of sand. |

NC-28d

| | |
|---------|--|
| 0-2 | Topsoil |
| 2-20 | med.-coarse brown sand & gravel, some cobbles. |
| 20-35 | med.-coarse dark brown sand & gravel. |
| 35-50 | clean fine-med. brown sand, trace silt. |
| 50-60 | fine-med. brown sand-silt. |
| 60-84 | (dark) gray silty clay lenses of sand. |
| 84-96 | fine red sandy silt. |
| 96-114 | fine med. brown sand. |
| 114-133 | fine-med. red brown sand. |
| 133-135 | white clay (red lenses) |

NC-29s

| | |
|-------|---|
| 0-2 | Topsoil |
| 2-5 | fine brown sandy silt. |
| 5-10 | med.-coarse brown silty sand & gravel. |
| 10-16 | med.-coarse sand & gravel. |
| 16-30 | med.-coarse dark brown sand & gravel seam of gray white clay. |
| 30-60 | med. coarse red sand, trace silt. |

NC-29d

0-2 black fill.
2-8 coarse gravel, med.-sand, mix yellow clay.
8-12 coarse gravel, med.-fine sand, yellow.
12-36 fine gravel, med.-fine sand, yellow.
36-120 fine light brown sand, layers coarse gravel.
120-125 gray silty clay.

NC-30d

0-7 coarse gravel silty sand mix.
7-18 coarse gravel, fine yellow sand with binder.
18-35 fine gravel, fine yellow sand with binders.
35-118 light brown fine sand with binder.
118-130 dark gray silty clay.

GCP-1

0-3 fill
3-10 light brown med.-coarse sand, med. gravel.
10-28 dark brown sand, fine-med. gravel.
28-59 dark brown fine-coarse sand, med.-coarse gravel.

GCP-2

0-2 fill
2-28 fine-coarse sand, fine-med. gravel, light brown.
28-59 tan, clean med.-coarse sand, fine gravel.

GCP #4

0-10 brown med.-coarse sand & gravel.
10-28 dark brown fine-med. sand, fine med. gravel.
28-40 dark brown fine-med. sand, fine gravel.
40-53 fine-med. light brown sand.

GCP #5

0-2 Topsoil
2-9 dark brown med.-coarse sand & gravel.
9-15 light brown med.-coarse sand & gravel.
15-42 dark brown med.-coarse sand, small gravel.
42-61 clean brown sand-med. coarse.

GCP #6

0-10 Med.-coarse brown sand & gravel.
10-25 dark brown fine-med. sand, some small red gravel.
25-40 fine-med. dark brown sand, fine gravel.
40-57 clean fine-med. light brown sand.